IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Applicant:	§	Confirmation No:
	§	
Noy Cohen	§	
	§	
Serial No.:		
Title: **DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL**		
	§	
Filed: Concurrently	§	
	§	Attorney Docket: Coreph-0159 US NP

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

PRELIMINARY AMENDMENT

Sir/Madam

Before substantive examination, Applicant respectfully requests that claims 1-21 be amended to remove multiple dependencies existing in claims 10-12, 20 and 21 of international patent application PCT/IB2016/053803 of which this is a 371 national phase application.

IN THE CLAIMS:

Please amend the claims as follows:

1. (Original) A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

2. (Original) The camera of claim 1, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

3. (Original) The camera of claim 1, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

4. (Original) The camera of claim 1, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

5. (Original) The camera of claim 1, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

6. (Original) The camera of claim 1, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

7. (Original) The camera of claim 1, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

8. (Original) The camera of claim 1, wherein the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

9. (Original) The camera of claim 8, wherein the user inputs include a zoom factor, a camera mode and a region of interest.

10. (Currently amended) The camera of ~~any of~~ the claim~~s~~ 1~~-9~~, wherein the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1.

11. (Currently amended) The camera of ~~any of~~ the claim~~s~~ 1~~-9~~, wherein, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

12. (Currently amended) The camera of ~~any of~~ the claim~~s~~ 1~~-9~~, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

13. (Original) A method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV) and a Wide sensor, a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

14. (Original) The method of claim 13, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

15. (Original) The method of claim 13, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

16. (Original) The method of claim 13, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

17. (Original) The method of claim 13, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

18. (Original) The method of claim 13, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

19. (Original) The method of claim 13, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third threshold distance.

20. (Currently amended) The method of ~~any of the~~ claim~~s~~ 13~~-19~~, further comprising the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

21. (Currently amended) The method of ~~any of the~~ claim~~s~~ 13~~-19~~, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

REMARKS

This preliminary amendment amends claims 10-12 and 20, 21 of international application PCT/IB2016/053803 by removing multiple dependencies from those claims. No new matter is introduced.

It is respectfully submitted that claims 1-21 are in condition for allowance. Prompt notice of allowance is respectfully and earnestly solicited.

Respectfully submitted,

/ Menachem Nathan /
Menachem Nathan
Agent for Applicant
Registration No. 65392

Date: January 8, 2017

DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)

☒ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)

Attorney Docket Number	COREPH-0159 US NP
First Named Inventor	Noy Cohen
COMPLETE IF KNOWN	
Application Number	
Filing Date	2017-01-08
Art Unit	
Examiner Name	

DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

(Title of the Invention)

As a below named inventor, I hereby declare that:

This declaration is directed to:

☒ The attached application,

OR

☐ United States Application Number or PCT International application number ________________

filed on ________________.

The above-identified application was made or authorized to be made by me.

I believe I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

Direct all correspondence to: ☒ The address associated with Customer Number: **92342** **OR** ☐ Correspondence address below

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PTO/AIA/08 (11-15)
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DECLARATION — Utility or Design Patent Application

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LEGAL NAME OF SOLE OR FIRST INVENTOR:

(*E.g.*, Given Name (first and middle if any) and Family Name or Surname)
Noy Cohen

Inventor's Signature	Date (Optional)
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☒ Additional inventors are being named on the 2 Supplemental sheet(s) PTO/AIA/10 attached hereto

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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet

Page 1 of 2

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
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City: Tel-Aviv	State	Zip: 6958313	Country: IL

DECLARATION – Supplemental Priority Data Sheet

Foreign applications:

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
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If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

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DECLARATION

ADDITIONAL INVENTOR(S)
Supplemental Sheet
Page 2 of 2

Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor		
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City: Ashdod	State:	Zip: 7751025	Country: IL

DECLARATION – Supplemental Priority Data Sheet

Foreign applications:

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
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Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Filer:	Menachem Nathan
Attorney Docket Number:	COREPH-0159 US NP

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
BASIC NATIONAL STAGE FEE	2631	1	140	140
Natl Stage Search Fee - U.S. was the ISA	2641	1	60	60
NATL STAGE EXAM FEE - ALL OTHER CASES	2633	1	360	360
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2615	1	40	40
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
	Total in USD ($)			**600**

Electronic Acknowledgement Receipt

EFS ID:	28002370
Application Number:	15324720
International Application Number:	PCT/IB2016/053803
Confirmation Number:	5811
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
Filer:	Menachem Nathan
Filer Authorized By:	
Attorney Docket Number:	COREPH-0159 US NP
Receipt Date:	08-JAN-2017
Filing Date:	
Time Stamp:	16:07:49
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$600
RAM confirmation Number	010917INTEFSW16124200
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Specification	filing.pdf	665880 7d9c36fc0963ac959854226c3e2a028584b58a78	no	26
Warnings:					
Information:					
2	Application Data Sheet	ADS.pdf	1823740 965271d63486d55f3d869d5cc1b37d2c62262c59	no	10
Warnings:					
Information:					
3	Preliminary Amendment	Preliminary_Amendment.pdf	41018 01598f7489b5f49156c383e67f2104ba87983b3b	no	6
Warnings:					
Information:					
4	Oath or Declaration filed	Declaration.pdf	1956566 6819c7e69d1d5d4921c2d6f1a106a18dc9ed43f5	no	3
Warnings:					
Information:					
5	Oath or Declaration filed	Declaration_AI.pdf	364206 2949f9712de2baa59f043ea8d56c616760426960	no	3
Warnings:					
Information:					
6	Oath or Declaration filed	Declaration_A2.pdf	364307 207983c6afba583c3c0140b7302cdbcf25c15d49	no	3
Warnings:					
Information:					

7	Fee Worksheet (SB06)	fee-info.pdf	37007 aaf232644a64e6b8d675d177e4eb94f2f8e936c1	no	2

Warnings:

Information:

Total Files Size (in bytes):	5252724

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a 371 application from international patent application PCT/IB2016/053803 filed June 26, 2016, and is related to and claims priority from US Provisional Patent Application No. 62/204,667 filed August 13, 2015 which is expressly incorporated herein by reference in its entirety.

FIELD

Embodiments disclosed herein relate in general to digital cameras and in particular to zoom digital cameras with video capabilities.

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size. Further, there is an increasing demand for such cameras to have higher-performance characteristics. One such characteristic possessed by many higher-performance cameras (e.g., standalone digital still cameras) is the ability to vary the focal length of the camera to increase and decrease the magnification of the image. This ability, typically accomplished with a zoom lens, is known as optical zooming. "Zoom" is commonly understood as a capability to provide different magnifications of the same scene and/or object by changing the focal length of an optical system, with a higher level of zoom associated with greater magnification and a lower level of zoom associated with lower magnification. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other. Such zoom lenses are typically more expensive, larger and less reliable than fixed focal length lenses. An alternative approach for approximating the zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a magnified but lower-resolution image.

Attempts to use multi-aperture imaging systems to approximate the effect of a zoom lens are known. A multi-aperture imaging system (implemented for example in a digital camera) includes a plurality of optical sub-systems (also referred to as "cameras"). Each camera includes one or more lenses and/or other optical elements which define an aperture such that received electro-magnetic radiation is imaged by the optical sub-system and a resulting image is directed towards a two-dimensional (2D) pixelated image sensor region. The image sensor (or simply "sensor") region is configured to receive the image and to generate a set of image data based on the image. The digital camera may be aligned to receive electromagnetic radiation associated with scenery having a given set of one or more objects. The set of image data may be represented as digital image data, as well known in the art. Hereinafter in this description, "image" "image data" and "digital image data" may be used interchangeably. Also, "object" and "scene" may be used interchangeably. As used herein, the term "object" is an entity in the real world imaged to a point or pixel in the image.

Multi-aperture imaging systems and associated methods are described for example in US Patent Publications No. 2008/0030592, 2010/0277619 and 2011/0064327. In US 2008/0030592, two sensors are operated simultaneously to capture an image imaged through an associated lens. A sensor and its associated lens form a lens/sensor combination. The two lenses have different focal lengths. Thus, even though each lens/sensor combination is aligned to look in the same direction, each combination captures an image of the same subject but with two different fields of view (FOV). One sensor is commonly called “Wide” and the other “Tele”. Each sensor provides a separate image, referred to respectively as “Wide” (or “W”) and “Tele” (or “T”) images. A W-image reflects a wider FOV and has lower resolution than the T-image. The images are then stitched (fused) together to form a composite ("fused") image. In the composite image, the central portion is formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length, and the peripheral portion is formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values from the chosen amount of zoom to provide a respective zoom image. The solution offered by US 2008/0030592 requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).

US 2010/0277619 teaches a camera with two lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a FOV approximately 2-3 times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image is provided from the lens/sensor combination having a FOV that is next larger than the requested FOV. Thus, if the requested FOV is less than the smaller FOV combination, the zoomed image is created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested FOV is greater than the smaller FOV combination, the zoomed image is created from the image captured by the other combination, using cropping and interpolation if necessary. The solution offered by US 2010/0277619 leads to parallax artifacts when moving to the Tele camera in video mode.

In both US 2008/0030592 and US 2010/0277619, different focal length systems cause matching Tele and Wide FOVs to be exposed at different times using CMOS sensors. This degrades the overall image quality. Different optical F numbers ("F#") cause image intensity differences. Working with such a dual sensor system requires double bandwidth support, i.e. additional wires from the sensors to the following HW component. Neither US 2008/0030592 nor US 2010/0277619 deal with registration errors.

US 2011/0064327 discloses multi-aperture imaging systems and methods for image data fusion that include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes overlap at least partially in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data cameras such that each of the cameras is based on at least one characteristic of the second collection, and each camera spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data cameras. The systems and methods disclosed in this application deal solely with fused still images.

None of the known art references provide a thin (e.g. fitting in a cell-phone) dual-aperture zoom digital camera with fixed focal length lenses, the camera configured to operate in both still mode and video mode to provide still and video images, wherein the camera configuration does not use any fusion to provide a continuous, smooth zoom in video mode.

Therefore there is a need for, and it would be advantageous to have thin digital cameras with optical zoom operating in both video and still mode that do not suffer from commonly encountered problems and disadvantages, some of which are listed above.

SUMMARY

Embodiments disclosed herein teach the use of dual-aperture (also referred to as dual-lens or two-sensor) optical zoom digital cameras. The cameras include two cameras, a Wide camera and a Tele camera, each camera including a fixed focal length lens, an image sensor and an image signal processor (ISP). The Tele camera is the higher zoom camera and the Wide camera is the lower zoom camera. In some embodiments, the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1. The image sensor may include two separate 2D pixelated sensors or a single pixelated sensor divided into at least two areas. The digital camera can be operated in both still and video modes. In video mode, optical zoom is achieved "without fusion", by, in some embodiments, switching between the W and T images to shorten computational time requirements, thus enabling high video rate. To avoid discontinuities in video mode, the switching includes applying additional processing blocks, which include in some embodiments image scaling and shifting. In some embodiments, when a no-switching criterion is fulfilled, optical zoom is achieved in video mode without switching.

As used herein, the term "video" refers to any camera output that captures motion by a series of pictures (images), as opposed to "still mode" that friezes motion. Examples of "video" in cellphones and smartphones include "video mode" or "preview mode".

In order to reach optical zoom capabilities, a different magnification image of the same scene is captured (grabbed) by each camera, resulting in FOV overlap between the two cameras. Processing is applied on the two images to fuse and output one fused image in still mode. The fused image is processed according to a user zoom factor request. As part of the fusion procedure, up-sampling may be applied on one or both of the grabbed images to scale it to the image grabbed by the Tele camera or to a scale defined by the user. The fusion or up-sampling may be applied to only some of the pixels of a sensor. Down-sampling can be performed as well if the output resolution is smaller than the sensor resolution.

The cameras and associated methods disclosed herein address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras. They provide an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW).

In a dual-aperture camera image plane, as seen by each camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either camera image or the shape or position of a combination thereof. If the output image retains the Wide image shape then it has the Wide perspective POV. If it retains the Wide camera position then it has the Wide position POV. The same applies for Tele images position and perspective. As used in this description, the perspective POV may be of the Wide or Tele cameras, while the position POV may shift continuously between the Wide and Tele cameras. In fused images, it is possible to register Tele image pixels to a matching pixel set within the Wide image pixels, in which case the output image will retain the Wide POV ("Wide fusion"). Alternatively, it is possible to register Wide image pixels to a matching pixel set within the Tele image pixels, in which case the output image will retain the Tele POV ("Tele fusion"). It is also possible to perform the registration after either camera image is shifted, in which case the output image will retain the respective Wide or Tele perspective POV.

In an exemplary embodiment, there is provided a zoom digital camera comprising a Wide imaging section that includes a fixed focal length Wide lens with a Wide FOV and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene, a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene, and a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

In an exemplary embodiment there is provided a method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of providing in the digital camera a Wide imaging section having a Wide lens with a Wide FOV and a Wide sensor, a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections, and configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF value and a higher ZF value.

In some exemplary embodiments, the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

In some exemplary embodiments, the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

In some exemplary embodiments, the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

In some exemplary embodiments, the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

In some exemplary embodiments, the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

In some exemplary embodiments, the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

In some exemplary embodiments, the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

In some exemplary embodiments, the user inputs include a zoom factor, a camera mode and a region of interest.

In some exemplary embodiments, the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1. For a definition of TTL and EFL see e,g. co-assigned US published patent application No. 20150244942.

In some exemplary embodiments, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

In some exemplary embodiments, the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting examples of embodiments disclosed herein are described below with reference to figures attached hereto that are listed following this paragraph. Identical structures, elements or parts that appear in more than one figure are generally labeled with a same numeral in all the figures in which they appear. The drawings and descriptions are meant to illuminate and clarify embodiments disclosed herein, and should not be considered limiting in any way.

FIG. 1A shows schematically a block diagram illustrating an exemplary dual-aperture zoom imaging system disclosed herein;

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A:

FIG. 2 shows an example of a Wide sensor, a Tele sensor and their respective FOVs;

FIG. 3A shows an embodiment of an exemplary method disclosed herein for acquiring a zoom image in video/preview mode;

FIG. 3B shows exemplary feature points in an object;

FIG. 3C shows schematically a known rectification process;

FIG. 4 shows a graph illustrating an effective resolution zoom factor.

DETAILED DESCRIPTION

Definitions:

Sharpness score: the gradients (dx, dy) of the image are compared (through subtraction) to the gradients of its low pass filtered version. A higher difference indicates a sharper original image. The result of this comparison is normalized with respect to the average variations (for example, sum of absolute gradients) of the original image, to obtain an absolute sharpness score.

Edge score: for each image, the edges are found (for example, using Canny edge detection) and the average intensity of gradients along them is calculated, for example, by calculating the magnitude of gradients (dx, dy) for each edge pixel, summing the results and dividing by the total number of edge pixels. The result is the edge score.

Effective resolution score: this score is calculated only in a region of interest (ROI) and provides a good indication of the effective resolution level in the image. As used herein, "ROI" is a user-defined sub-region of the image that may be exemplarily 4% or less of the image area. The effective resolution score can be derived from a combination of the sharpness scores and edge scores for each image, for example by normalizing both to be between [0, 1] and by taking their average.

FIG. 1A shows schematically a block diagram illustrating an exemplary embodiment of a dual-aperture zoom imaging system (also referred to simply as “dual-camera” or "dual-aperture camera") disclosed herein and numbered **100**. Dual-aperture camera **100** comprises a Wide imaging section (“Wide camera”) that includes a Wide lens block **102,** a Wide image sensor **104** and a Wide image processor **106.** Dual-aperture camera **100** further comprises a Tele imaging section (“Tele camera”) that includes a Tele lens block **108**, a Tele image sensor **110** and a Tele image processor **112**. The image sensors may be physically separate or may be part of a single larger image sensor. The Wide sensor pixel size can be equal to or different from the Tele sensor pixel size. Dual-aperture camera **100** further comprises a camera fusion processing core (also referred to as “controller”) **114** that includes a sensor control module **116**, a user control module **118,** a video processing module **126** and a capture processing module **128,** all operationally coupled to sensor control block **110**. User control module **118** comprises an operational mode function **120**, a ROI function **122** and a zoom factor (ZF) function **124**.

Sensor control module **116** is connected to the two (Wide and Tele) cameras and to the user control module **118** and used to choose, according to the zoom factor, which of the sensors is operational and to control the exposure mechanism and the sensor readout. Mode choice function **120** is used for choosing capture/video modes. ROI function **122** is used to choose a region of interest. The ROI is the region on which both cameras are focused on. Zoom factor function **124** is used to choose a zoom factor. Video processing module **126** is connected to mode choice function **120** and used for video processing. It is configurable to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data and to make a decision regarding video output. Specifically, upon evaluation of a no-switching criterion, if the no-switching criterion is fulfilled, module **126** is configurable to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value. If the no-switching criterion is not fulfilled, module **126** is configurable to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view. Still processing module **128** is connected to the mode choice function **120** and used for high image quality still mode images. The video processing module is applied when the user desires to shoot in video mode. The capture processing module is applied when the user wishes to shoot still pictures.

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A. Exemplary dimensions: Wide lens TTL = 4.2mm and EFL = 3.5mm; Tele lens TTL = 6mm and EFL = 7 mm; both Wide and Tele sensors 1/3 inch; external dimensions of Wide and Tele cameras: width (w) and length (l) = 8.5 mm and height (h) = 6.8 mm; distance "d" between camera centers = 10mm.

Following is a detailed description and examples of different methods of use of dual-aperture camera **100**.

Still mode operation/function

In still camera mode, the obtained image is fused from information obtained by both cameras at all zoom levels, see FIG. 2, which shows a Wide sensor **202** and a Tele sensor **204** and their respective FOVs. Exemplarily, as shown, the Tele sensor FOV is half the Wide sensor FOV. The still camera mode processing includes two stages: the first stage includes setting HW settings and configuration, where a first objective is to control the sensors in such a way that matching FOVs in both images (Tele and Wide) are scanned at the same time, a second objective is to control the relative exposures according to the lens properties, and a third objective is to minimize the required bandwidth from both sensors for the ISPs. The second stage includes image processing that fuses the Wide and the Tele images to achieve optical zoom, improves SNR and provides wide dynamic range.

FIG. 3A shows image line numbers vs. time for an image section captured by CMOS sensors. A fused image is obtained by line (row) scans of each image. To prevent matching FOVs in both sensors to be scanned at different times, a particular configuration is applied by the camera controller on both image sensors while keeping the same frame rate. The difference in FOV between the sensors determines the relationship between the rolling shutter time and the vertical blanking time for each sensor.

Video mode operation/function

<u>Smooth transition</u>

When a dual-aperture camera switches the camera output between cameras or points of view, a user will normally see a "jump" (discontinuous) image change. However, a change in the zoom factor for the same camera and POV is viewed as a continuous change. A “smooth transition” (ST) is a transition between cameras or POVs that minimizes the jump effect. This may include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the camera outputs is in many cases impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in a smooth transition as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

Zoom-in and Zoom-out in video mode

In video mode, sensor oversampling is used to enable continuous and smooth zoom experience. Processing is applied to eliminate the changes in the image during crossover from one camera to the other. Zoom from 1 to Z_{switch} is performed using the Wide sensor only. From Z_{switch} and on, it is performed mainly by the Tele sensor. To prevent “jumps” (roughness in the image), switching to the Tele image is done using a zoom factor which is a bit higher (Z_{switch} +ΔZoom) than Z_{switch}. ΔZoom is determined according to the system's properties and is different for cases where zoom-in is applied and cases where zoom-out is applied ($\Delta Zoom_{in} \neq \Delta Zoom_{out}$). This is done to prevent residual jumps artifacts to be visible at a certain zoom factor. The switching between sensors, for an increasing zoom and for decreasing zoom, is done on a different zoom factor.

The zoom video mode operation includes two stages: (1) sensor control and configuration and (2) image processing. In the range from 1 to Z_{switch}, only the Wide sensor is operational, hence, power can be supplied only to this sensor. Similar conditions hold for a Wide AF mechanism. From Z_{switch}+ΔZoom to Z_{max} only the Tele sensor is operational, hence, power is supplied only to this sensor. Similarly, only the Tele sensor is operational and power is supplied only to it for a Tele AF mechanism. Another option is that the Tele sensor is operational and the Wide sensor is working in low frame rate. From Z_{switch} to Z_{switch}+ΔZoom, both sensors are operational.

Zoom-in: at low ZF up to slightly above ZF_T (the zoom factor that enables switching between Wide and Tele outputs) the output image is the digitally zoomed, unchanged Wide camera output. ZF_T is defined as follows:

$$ZF_T = \mathrm{Tan}\,(FOV_{Wide})/\mathrm{Tan}\,(FOV_{Tele})$$

where Tan refers to “tangent”, while FOV_{Wide} and FOV_{Tele} refer respectively to the Wide and

Tele lens fields of view (in degrees). As used herein, the FOV is measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition). Switching cannot take place below ZF_T and it can above it.

In some embodiments for the up-transfer ZF, as disclosed in co-invented and co-owned US patent 9,185,291, the output is a transformed Tele camera output, where the transformation is performed by a global registration (GR) algorithm to achieve smooth transition. As used herein "global registration" refers to an action for which the inputs are the Wide and Tele images. The Wide image is cropped to display the same FOV as the Tele image. The Tele image is passed through a low pass filter (LPF) and resized to make its appearance as close as possible to the Wide image (lower resolution and same pixel count). The outputs of GR are corresponding feature point pairs in the images along with their disparities, and parameters for differences between the images, i.e. shift and scale. As used herein, "feature point" refers to a point such as points **10a-d** in FIG. 3B and refers to a point (pixel) of interest on an object in an image. For purposes set forth in this description, a feature point should be reproducible and invariant to changes in image scale, noise and illumination. Such points usually lie on corners or other high-contrast regions of the object.

Stages of Global Registration

In some exemplary embodiments, global registration may be performed as follows:

1. Find interest points (features) in each image separately by filtering it with, exemplarily, a Difference of Gaussians filter, and finding local extrema on the resulting image.

2. Find feature correspondences (features in both images that describe the same point in space) in a "matching" process. These are also referred to as "feature pairs", "correspondence pairs" or "matching pairs". This is done by comparing each feature point from one (Tele or Wide) image (referred to hereinafter as "image 1") to all feature points in that region from the other (respectively Wide or Tele) image (referred to hereinafter as "image 2"). The features are compared only within their group of minima/maxima, using patch normalized cross-correlation. As used herein, "patch" refers to a group of neighboring pixels around an origin pixel.

3. The normalized cross correlation of two image patches $t(x,y)$ and $f(x,y)$ is $\frac{1}{n}\sum_{x,y}\frac{(f(x,y)-\bar{f})(t(x,y)-\bar{t})}{\sigma_f\sigma_t}$ where n is the number of pixels in both patches, $\bar{f}$ is the average of f and σ_f is the standard deviation of f. A match for a feature point from image 1 is only

confirmed if its correlation score is much higher (for example, x1.2) than the next-best matching feature from image 2.

4. Find the disparity between each pair of corresponding features (also referred to as "matching pair") by subtracting their x and y coordinate values.

5. Filter bad matching points:

a. Following the matching process, matches that include feature points from image 2 that were matched to more than one feature from image 1 are discarded.

b. Matching pairs whose disparity is inconsistent with the other matching pairs are discarded. For example, if there is one corresponding pair which whose disparity is lower or higher than the others by 20 pixels.

6. The localization accuracy for matched points from image 2 is refined by calculating a correlation of neighboring pixel patches from image 2 with the target patch (the patch around the current pixel (of the current matching pair) from image 1, modeling the results as a parabola and finding its maximum.

7. Rotation and fine scale differences are calculated between the two images according to the matching points (for example, by subtracting the center of mass from each set of points, i.e. the part of the matching points belonging to either the Wide or the Tele image, and solving a least squares problem).

8. After compensating for these differences, since the images were rectified, the disparity in the Y axis should be close to 0. Matching points that do not fit this criterion are discarded. A known rectification process is illustrated in FIG. 3C.

9. Finally, the remaining matching points are considered true and the disparities for them are calculated. A weighted average of the disparity is taken as the shift between both images. The maximum difference between disparity values is taken as the disparity range.

10. At various stages during GR, if there are not enough feature/matching points remaining, the GR is stopped and returns a failure flag.

In addition, it is possible to find range calibration to the rectification process by finding the shiftI = shift for objects at infinity and defining shiftD=shift-shiftI and disparity D = disparity-shiftI. We then calculate $object\ distance = \frac{focalLength \cdot baseline}{disparityD \cdot pixelSize}$, where "baseline" is the distance between cameras.

Returning now to the Zoom-in process, in some embodiments, for higher ZF than the up-transfer ZF the output is the transformed Tele camera output, digitally zoomed. However, in other embodiments for the up-transfer ZF there will be no switching from the Wide to the

Tele camera output, i.e. the output will be from the Wide camera, digitally zoomed. This "no switching" process is described next.

No Switching

Switching from the Wide camera output to the transformed Tele camera output will be performed unless some special condition (criterion), determined based on inputs obtained from the two camera images, occurs. In other words, switching will not be performed only if at least one of the following no-switching criteria is fulfilled:

1. if the shift calculated by GR is greater than a first threshold, for example 50 pixels.
2. if the disparity range calculated by GR is greater than a second threshold, for example 20 pixels, because in this case there is no global shift correction that will suppress movement/jump for all objects distances (smooth transition is impossible for all objects).
3. if the effective resolution score of the Tele image is lower than that of the Wide image. In this case, there is no point in performing the transition because no value (i.e. resolution) is gained. Smooth transition is possible but undesirable.
4. if the GR fails, i.e. if the number of matching pairs found is less than a third threshold, for example 20 matching pairs.
5. if, for example, that are imaged onto the overlap area are calculated to be closer than a first threshold distance, for example 30 cm, because this can result in a large image shift to obtain ST.
6. if some objects (for example two objects) that are imaged in the overlap area are calculated to be closer than a second threshold distance, for example 50 cm, while other objects (for example two objects) are calculated to be farther than a third threshold distance for example 10 m. The reason is that the shift between an object position in the Wide and Tele cameras is object distance dependent, where the closer the objects the larger the shift, so an image containing significantly close and far objects cannot be matched by simple transformation (shift scale) to be similar and thus provide ST between cameras.

Zoom-out: at high ZF down to slightly below Z_{FT}, the output image is the digitally zoomed transformed Tele camera output. For the down-transfer ZF, the output is a shifted Wide camera output, where the Wide shift correction is performed by the GR algorithm to achieve smooth transition, i.e. with no jump in the ROI region. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

Note that if a no-switching criterion is not fulfilled, then the camera will output without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, the video output images being provided with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

FIG. 3A shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode for 3 different zoom factor (ZF) ranges: (a) ZF range = 1 : Z_{switch}; (b) ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$: and (c) Zoom factor range = Z_{switch} + $\Delta Zoom_{in}$: Z_{max}. The description is with reference to a graph of effective resolution vs. zoom factor (FIG. 4). In step **302**, sensor control module **116** chooses (directs) the sensor (Wide, Tele or both) to be operational. Specifically, if the ZF range = 1:Z_{switch}, module **116** directs the Wide sensor to be operational and the Tele sensor to be non-operational. If the ZF range is Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, module **116** directs both sensors to be operational and the zoom image is generated from the Wide sensor. If the ZF range is Z_{switch} + $\Delta Zoom_{in}$: Z_{max}, module **116** directs the Wide sensor to be non-operational and the Tele sensor to be operational. After the sensor choice in step **302,** all following actions are performed in video processing core **126**. Optionally, in step **304,** color balance is calculated if two images are provided by the two sensors. Optionally yet, in step **306**, the calculated color balance is applied in one of the images (depending on the zoom factor). Further optionally, in step **308**, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient can be used to set an AF position in step **310**. In step **312**, an output of any of steps **302-308** is applied on one of the images (depending on the zoom factor) for image signal processing that may include denoising, demosaicing, sharpening, scaling, etc. In step **314**, the processed image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p). To avoid a transition point to be executed at the same ZF, $\Delta Zoom$ can change while zooming in and while zooming out. This will result in hysteresis in the sensor switching point.

In more detail, for ZF range 1: Z_{switch}, for ZF < $Z_{switch,}$ the Wide image data is transferred to the ISP in step **312** and resampled in step **314**. For ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, both sensors are operational and the zoom image is generated from the Wide sensor. The color balance is calculated for both images according to a given ROI. In addition, for a given ROI, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient is used to set an AF position. The transformation coefficient includes the translation between matching points in the two images. This translation can be measured in a number of pixels. Different translations will result in a different number of pixel movements between matching points in the images. This movement can be translated into depth and the depth can be translated into an AF position. This enables to set the AF position by only analyzing two images (Wide and Tele). The result is fast focusing.

Both color balance ratios and transformation coefficient are used in the ISP step. In parallel, the Wide image is processed to provide a processed image, followed by resampling. For ZF range = $Z_{switch} + \Delta Zoom_{in} : Z_{max}$ and for Zoom factor > $Z_{switch,} + \Delta Zoom_{in}$, the color balance calculated previously is now applied on the Tele image. The Tele image data is transferred to the ISP in step **312** and resampled in step **314**. To eliminate crossover artifacts and to enable smooth transition to the Tele image, the processed Tele image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p).

FIG. 4 shows the effective resolution as a function of the zoom factor for a zoom-in case and for a zoom-out case $\Delta Zoom_{up}$ is set when one zooms in, and $\Delta Zoom_{down}$ is set when one zooms out. Setting $\Delta Zoom_{up}$ to be different from $\Delta Zoom_{down}$ will result in transition between the sensors to be performed at different zoom factor ("hysteresis") when zoom-in is used and when zoom-out is used. This hysteresis phenomenon in the video mode results in smooth continuous zoom experience.

In conclusion, dual aperture optical zoom digital cameras and associate methods disclosed herein reduce the amount of processing resources, lower frame rate requirements, reduce power consumption, remove parallax artifacts and provide continuous focus (or provide loss of focus) when changing from Wide to Tele in video mode. They provide a dramatic reduction of the disparity range and avoid false registration in capture mode. They reduce image intensity differences and enable work with a single sensor bandwidth instead of two, as in known cameras.

All patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present disclosure.

While this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of the embodiments and methods will be apparent to those skilled in the art. The disclosure is to be understood as not limited by the specific embodiments described herein, but only by the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

2. The camera of claim 1, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

3. The camera of claim 1, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

4. The camera of claim 1, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

5. The camera of claim 1, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

6. The camera of claim 1, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

7. The camera of claim 1, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

8. The camera of claim 1, wherein the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

9. The camera of claim 8, wherein the user inputs include a zoom factor, a camera mode and a region of interest.

10. The camera of any of the claims 1-9, wherein the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1.

11. The camera of any of the claims 1-9, wherein, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

12. The camera of any of the claims 1-9, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

13. A method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV) and a Wide sensor, a Tele imaging section having a Tele lens with

a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

14. The method of claim 13, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

15. The method of claim 13, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

16. The method of claim 13, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

17. The method of claim 13, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

18. The method of claim 13, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

19. The method of claim 13, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third threshold distance.

20. The method of any of the claims 13-19, further comprising the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some

of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

21. The method of any of the claims 13-19, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

ABSTRACT

A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operatively coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The controller is configured to output, in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value, a zoom video output image that includes only Wide image data or only Tele image data, depending on whether a no-switching criterion is fulfilled or not.

100

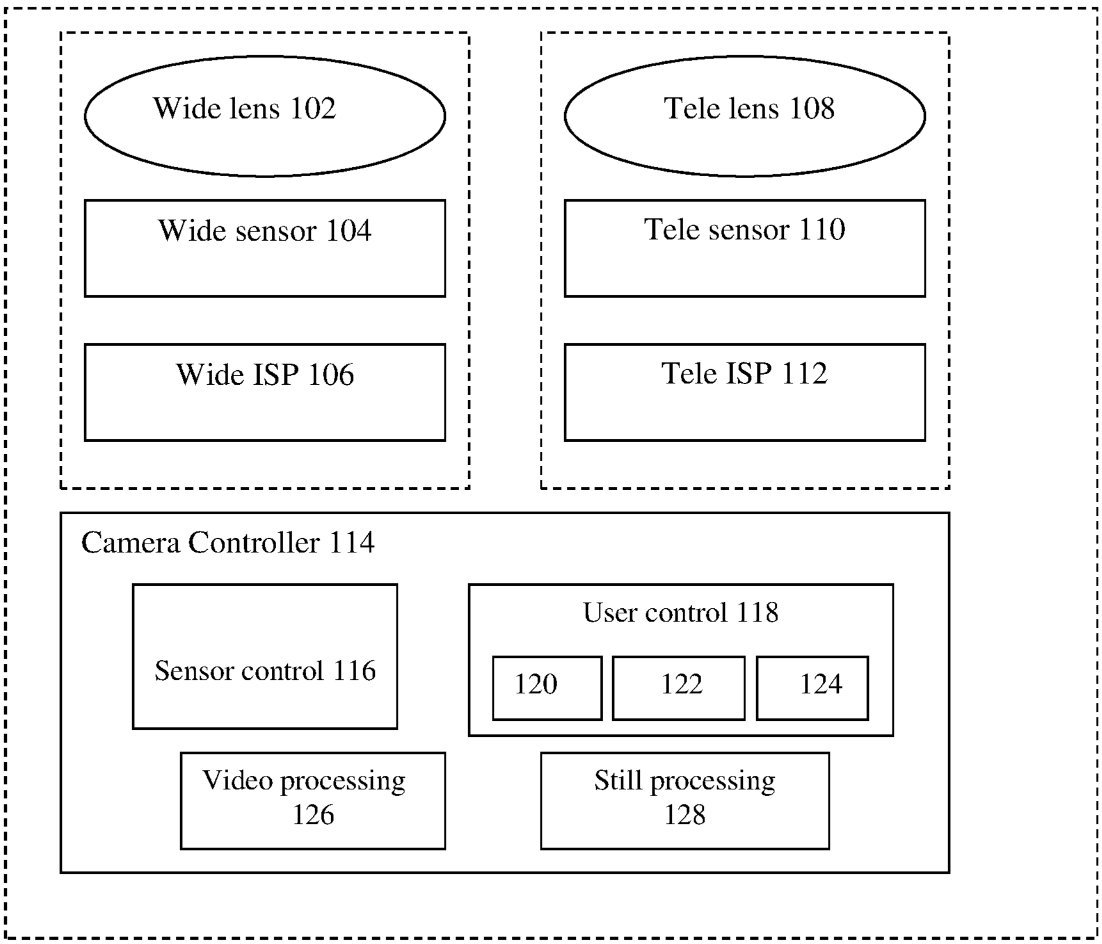

FIG. 1A

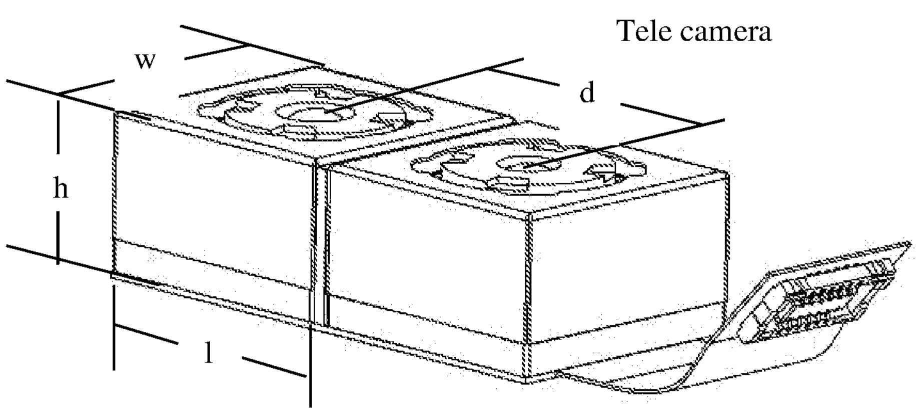

FIG. 1B

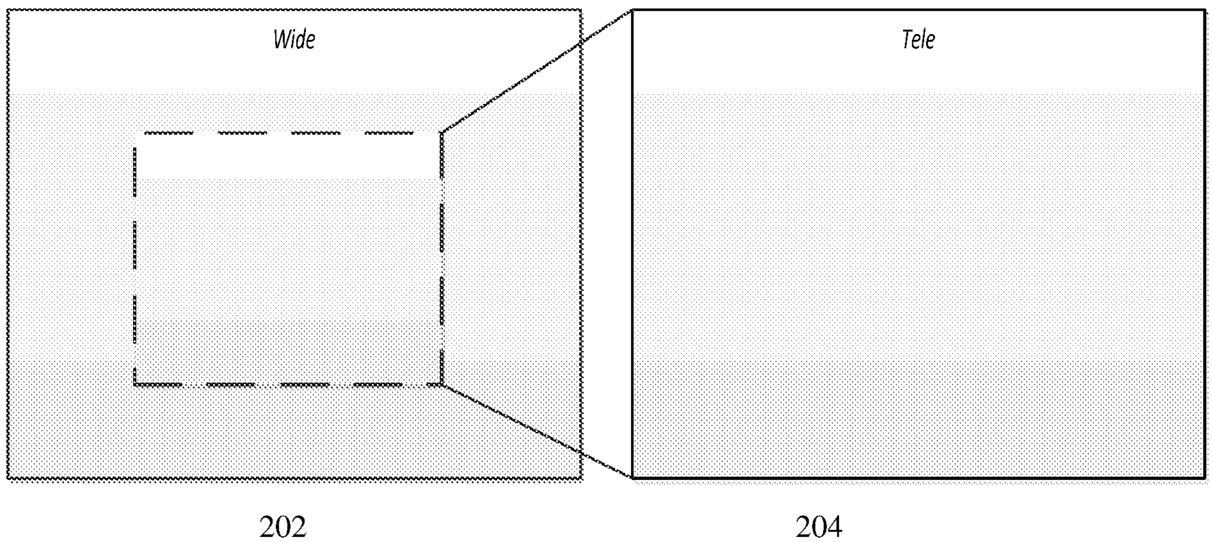

FIG. 2

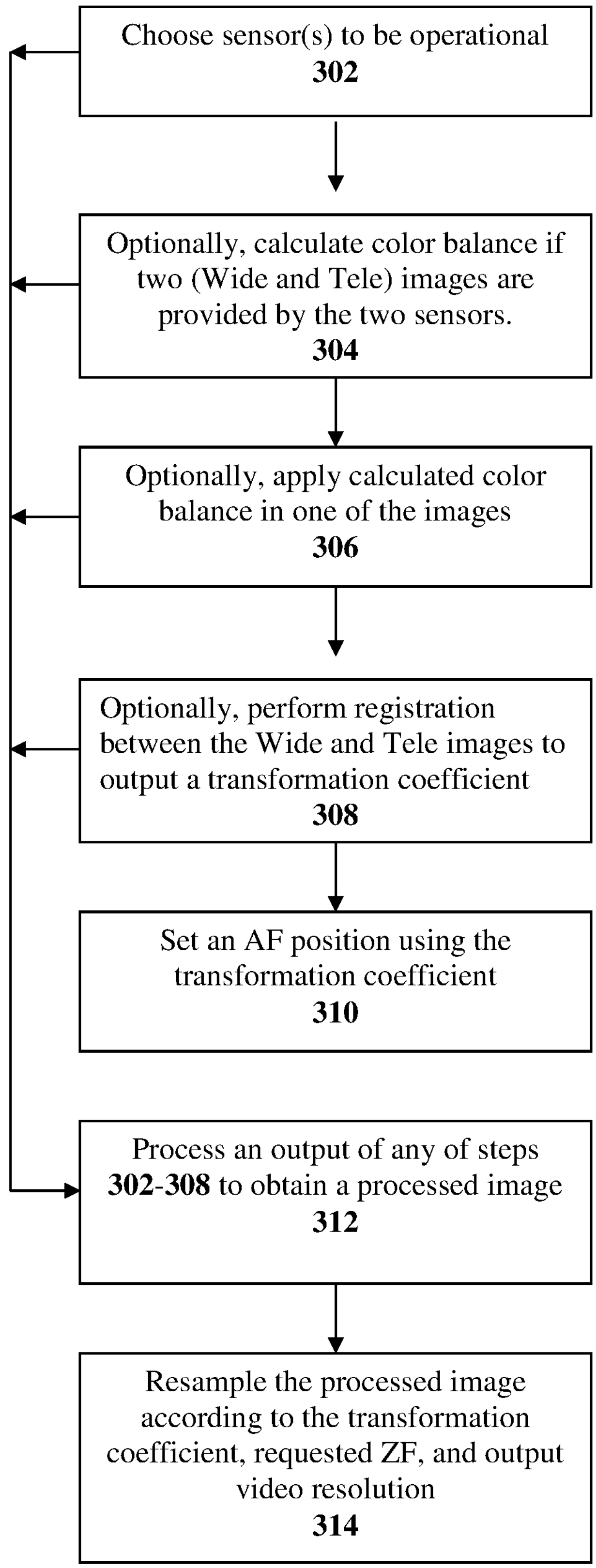
Choose sensor(s) to be operational
302
Optionally, calculate color balance if two (Wide and Tele) images are provided by the two sensors.
304
Optionally, apply calculated color balance in one of the images
306
Optionally, perform registration between the Wide and Tele images to output a transformation coefficient
308
Set an AF position using the transformation coefficient
310
Process an output of any of steps 302-308 to obtain a processed image
312
Resample the processed image according to the transformation coefficient, requested ZF, and output video resolution
314

FIG. 3A

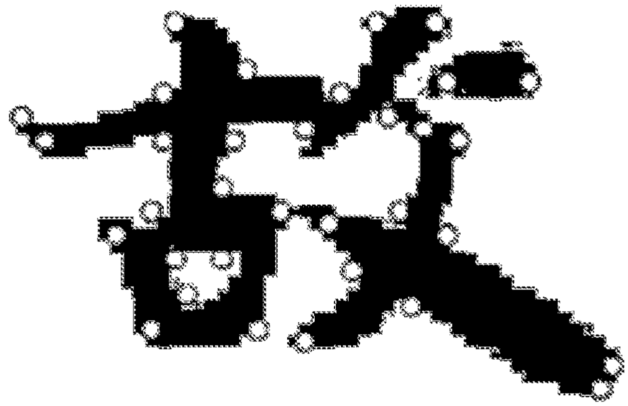

FIG. 3B

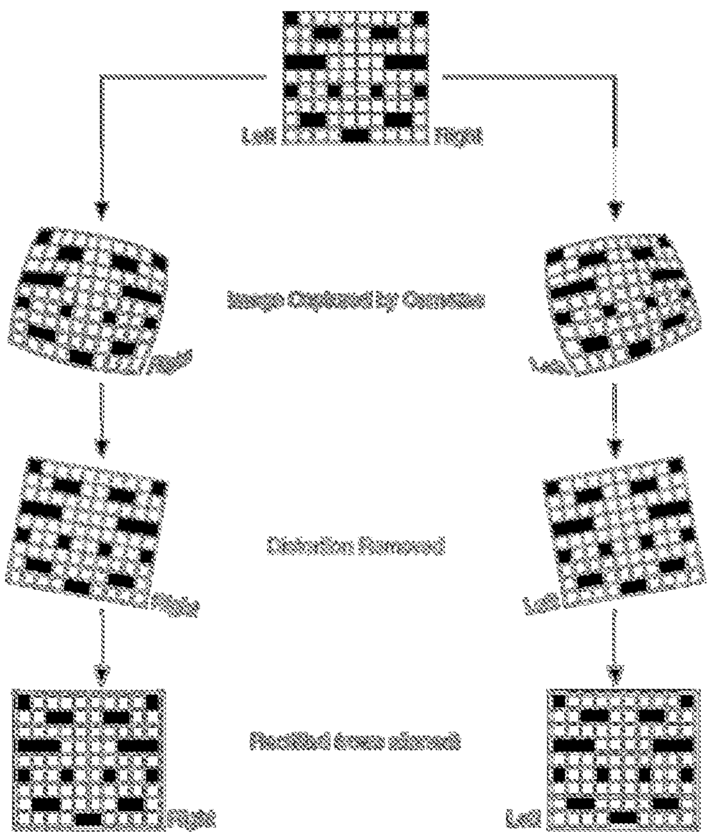

FIG. 3C

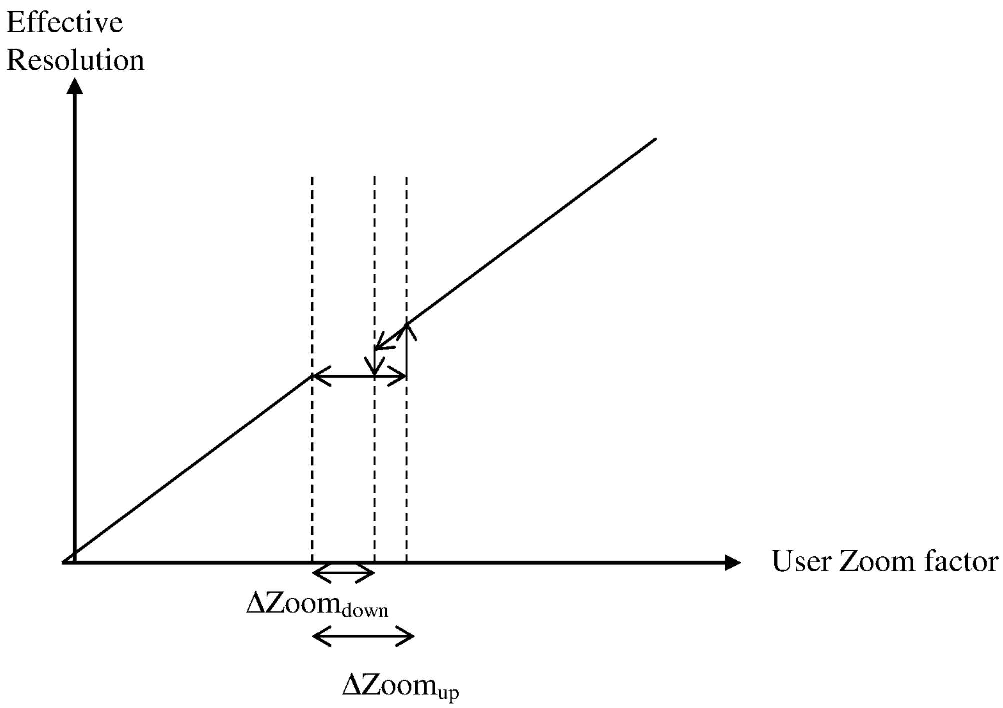

FIG. 4

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

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Prefix	Given Name	Middle Name	Family Name	Suffix
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

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City	Modi'in	State/Province	
Postal Code	7170202	Country i	IL

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

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Address 2			
City	Ashdod	**State/Province**	
Postal Code	7751025	**Country i**	IL

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	92342	
Email Address		Add Email Remove Email

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	

Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

Application Information:

Title of the Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL		
Attorney Docket Number	COREPH-0159 US NP	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	**Suggested Figure for Publication (if any)**	3A

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	92342		

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the “Application Number” field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	a 371 of international	PCT/IB2016/053803	2016-06-26
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
PCT/IB2016/053803	Claims benefit of provisional	62204667	2015-08-13
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.			Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

			Remove
Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.			Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:	
If the Applicant is an Organization check here.	☒
Organization Name	Corephotonics Ltd.

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Country	IL	Postal Code	6971035
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	

Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Menachem Nathan/			Date (YYYY-MM-DD)	2017-01-08
First Name	MENACHEM	Last Name	NATHAN	Registration Number	65392

Additional Signature may be generated within this form by selecting the Add button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US NP
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 92342

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignments documents attached to this form in accordance with 37 CFR 3.73(c).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(c) to:

☒ The address associated with Customer Number: 92342

OR

☐

Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address: Corephotonics Ltd.
25 Habarzel St.
Ramat Hachayal
Tel-Aviv, 6971035
ISRAEL

A copy of this form, together with a statement under 37 CFR 3.73(c) (Form PTO/AIA/96 or equivalent) is required to be Filed in each application in which this form is used. The statement under 37 CFR 3.73(c) may be completed by one of The practitioners appointed in this form, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	/Gal Shabtay/	Date	01-08-2017
Name	GAL SHABTAY	Telephone	
Title	VP-R&D		

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STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Corephotonics Ltd.

Application No./Patent No.: 15324720 Filed/Issue Date: 2017-01-08

Titled: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

Corephotonics Ltd. , a COMPANY

(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

☐ The extent (by percentage) of its ownership interest is ____________%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

A. ☑ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel ____________, Frame ____________, or for which a copy thereof is attached.

B. ☐ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: ________________________ To: ________________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

2. From: ________________________ To: ________________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: ______________________ To: ______________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

4. From: ______________________ To: ______________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

5. From: ______________________ To: ______________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

6. From: ______________________ To: ______________________

The document was recorded in the United States Patent and Trademark Office at

Reel ____________, Frame ____________, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☐ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Gal Shabtay	01-08-2017
Signature	Date
/Gal Shabtay/	VP-R&D
Printed or Typed Name	Title or Registration Number

[Page 2 of 2]

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99**)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS

Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8401276	B1	2013-03-19	Choe et al.	
	2	6104432	A	2000-08-15	Nakamura et al.	
	3	5710670	A	1998-01-20	Ohno	
	4	9185291	B1	2015-11-10	Shabtay et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS

Remove

Examiner Initial*	Cite No	Publication Number	Kind Code1	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030017930	A1	2003-09-25	Bittner	
	2	20090102950	A1	2009-04-23	Ahiska	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	3	20080030592	A1	2008-02-07	Border et al.	
	4	20100277619	A1	2010-11-04	Lawrence Scarff	
	5	20110064327	A1	2011-03-17	Joseph C. Dagher et al.	
	6	20150244942	A1	2015-08-27	Shabtay et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number3	Country Code2 i	Kind Code4	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T5
	1	2014199338	WO	A2	2014-12-18	Corephotonics Ltd.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	International Search Report and Written Opinion issued in relation to PCT patent application PCT/IB2016/053803 dated June 26, 2016, 9 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Menachem Nathan/	Date (YYYY-MM-DD)	2017-01-08
Name/Print	MENACHEM NATHAN	Registration Number	65392

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	COREPH-0159 US NP
First Named Inventor	Noy Cohen
Title	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NO
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☐ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☐ **Specification** [*Total Pages* ____]
   Both the claims and abstract must start on a new page.
   (See MPEP § 608.01(a) for information on the preferred arrangement)
5. ☐ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* ____]
6. **Inventor's Oath or Declaration** [*Total Pages* ____]
   (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))
   a. ☐ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
7. ☐ **Application Data Sheet** ** See note below.*
   See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R**
   in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission**
   (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

ACCOMPANYING APPLICATION PAPERS

10. ☐ **Assignment Papers**
    (cover sheet & document(s))
    Name of Assignee ____
11. ☐ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☐ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☑ **Information Disclosure Statement**
    (PTO/SB/08 or PTO-1449)
    ☑ Copies of citations attached
14. ☐ **Preliminary Amendment**
15. ☐ **Return Receipt Postcard**
    (*MPEP § 503*) (*Should be specifically itemized*)
16. ☐ **Certified Copy of Priority Document(s)**
    (*if foreign priority is claimed*)
17. ☐ **Nonpublication Request**
    Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
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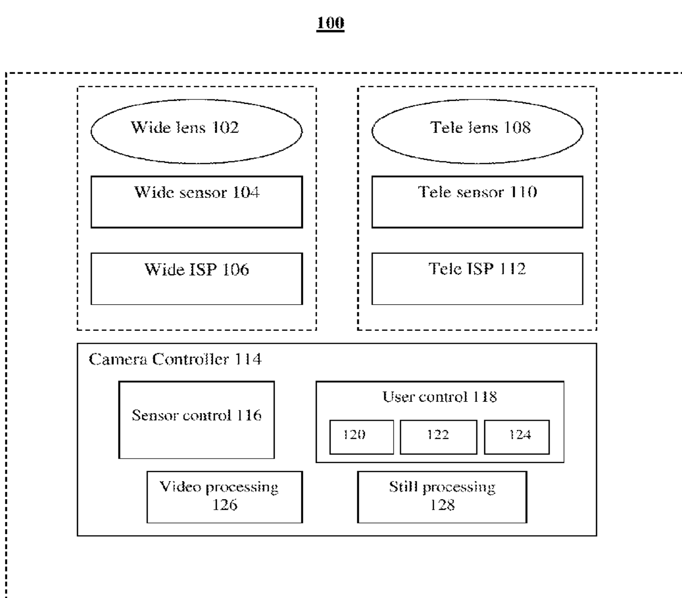

FIG. 1A

(57) Abstract: A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operative!y coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The controller is configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image from a particular point of view, and to provide without fusion continuous zoom video mode output images, each output image having a given output resolution, wherein the video mode output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, and wherein at the lower ZF the output resolution is determined by the Wide sensor while at the higher ZF value the output resolution is determined by the Tele sensor.

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DUAL APERTURE ZOOM DIGITAL CAMERA

CROSS REFERENCE TO RELATED APPLICATIONS

This application is related to and claims priority from US Provisional Patent Application No. 61/834,486 having the same title and filed June 13, 2013, which is incorporated herein by reference in its entirety.

FIELD

Embodiments disclosed herein relate in general to digital cameras and in particular to thin zoom digital cameras with both still image and video capabilities

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size. Further, there is an increasing demand for such cameras to have higher-performance characteristics. One such characteristic possessed by many higher-performance cameras (e.g., standalone digital still cameras) is the ability to vary the focal length of the camera to increase and decrease the magnification of the image. This ability, typically accomplished with a zoom lens, is known as optical zooming. "Zoom" is commonly understood as a capability to provide different magnifications of the same scene and/or object by changing the focal length of an optical system, with a higher level of zoom associated with greater magnification and a lower level of zoom associated with lower magnification. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other. Such zoom lenses are typically more expensive, larger and less reliable than fixed focal length lenses. An alternative approach for approximating the zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a magnified but lower-resolution image.

Attempts to use multi-aperture imaging systems to approximate the effect of a zoom lens are known. A multi-aperture imaging system (implemented for example in a digital camera) includes a plurality of optical sub-systems (also referred to as "sub-cameras"). Each sub-camera includes one or more lenses and/or other optical elements which define an aperture such that received electro-magnetic radiation is imaged by the optical sub-system and a resulting image is directed towards a two-dimensional (2D) pixelated image sensor region. The image sensor (or simply "sensor") region is configured to receive the image and to generate a set of image data based on the image. The digital camera may be aligned to receive electromagnetic radiation associated with scenery having a given set of one or more objects. The set of image data may be represented as digital image data, as well known in the art. Hereinafter in this description, "image" "image data" and "digital image data" may be used interchangeably. Also, "object" and "scene" may be used interchangeably.

Multi-aperture imaging systems and associated methods are described for example in US Patent Publications No. 2008/0030592, 2010/0277619 and 2011/0064327. In US 2008/0030592, two sensors are operated simultaneously to capture an image imaged through an associated lens. A sensor and its associated lens form a lens/sensor combination. The two lenses have different focal lengths. Thus, even though each lens/sensor combination is aligned to look in the same direction, each captures an image of the same subject but with two different fields of view (FOVs). One sensor is commonly called “Wide” and the other “Tele”. Each sensor provides a separate image, referred to respectively as “Wide” (or “W”) and “Tele” (or “T”) images. A W-image reflects a wider FOV and has lower resolution than the T-image. The images are then stitched (fused) together to form a composite ("fused") image. In the composite image, the central portion is formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length, and the peripheral portion is formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values from the chosen amount of zoom to provide a respective zoom image. The solution offered by US 2008/0030592 requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).

US 2010/0277619 teaches a camera with two lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a FOV approximately 2-3 times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image is provided from the lens/sensor combination having a FOV that is next larger than the requested FOV. Thus, if the requested FOV is less than the smaller FOV combination, the zoomed image is created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested FOV is greater than the smaller FOV combination, the zoomed image is created from the image captured by the other combination, using cropping and interpolation if necessary. The solution offered by US 2010/0277619 leads to parallax artifacts when moving to the Tele camera in video mode.

In both US 2008/0030592 and US 2010/0277619, different focal length systems cause Tele and Wide matching FOVs to be exposed at different times using CMOS sensors. This degrades the overall image quality. Different optical F numbers ("F#") cause image intensity differences. Working with such a dual sensor system requires double bandwidth support, i.e. additional wires from the sensors to the following HW component. Neither US 2008/0030592 nor US 2010/0277619 deal with registration errors. Neither US 2008/000592 nor US 2010/0277619 refer to partial fusion, i.e. fusion of less than all the pixels of both Wide and Tele images in still mode.

US 2011/0064327 discloses multi-aperture imaging systems and methods for image data fusion that include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes overlap at least partially in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data sub-cameras such that each of the sub-cameras is based on at least one characteristic of the second collection, and each sub-camera spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data sub-cameras. The systems and methods disclosed in this application deal solely with fused still images.

None of the known art references provide a thin (e.g. fitting in a cell-phone) dual-aperture zoom digital camera with fixed focal length lenses, the camera configured to operate in both still mode and video mode to provide still and video images, wherein the camera configuration uses partial or full fusion to provide a fused image in still mode and does not use any fusion to provide a continuous, smooth zoom in video mode.

Therefore there is a need for, and it would be advantageous to have thin digital cameras with optical zoom operating in both video and still mode that do not suffer from commonly encountered problems and disadvantages, some of which are listed above.

SUMMARY

Embodiments disclosed herein teach the use of dual-aperture (also referred to as dual-lens or two-sensor) optical zoom digital cameras. The cameras include two sub-cameras, a Wide sub-camera and a Tele sub-camera, each sub-camera including a fixed focal length lens, an image sensor and an image signal processor (ISP). The Tele sub-camera is the higher zoom sub-camera and the Wide sub-camera is the lower zoom sub-camera. In some embodiments, the lenses are thin lenses with short optical paths of less than about 9mm. In some embodiments, the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1. The image sensor may include two separate 2D pixelated sensors or a single pixelated sensor divided into at least two areas. The digital camera can be operated in both still and video modes. In still mode, zoom is achieved "with fusion" (full or partial), by fusing W and T images, with the resulting fused image including always information from both W and T images. Partial fusion may be achieved by not using fusion in image areas where the Tele image is not focused. This advantageously reduces computational requirements (e.g. time).

In video mode, optical zoom is achieved "without fusion", by switching between the W and T images to shorten computational time requirements, thus enabling high video rate. To avoid discontinuities in video mode, the switching includes applying additional processing blocks, which include image scaling and shifting.

In order to reach optical zoom capabilities, a different magnification image of the same scene is captured (grabbed) by each camera sub-camera, resulting in FOV overlap between the two sub-cameras. Processing is applied on the two images to fuse and output one fused image in still mode. The fused image is processed according to a user zoom factor request. As part of the fusion procedure, up-sampling may be applied on one or both of the grabbed images to scale it to the image grabbed by the Tele sub-camera or to a scale defined by the user. The fusion or up-sampling may be applied to only some of the pixels of a sensor. Down-sampling can be performed as well if the output resolution is smaller than the sensor resolution. .

The cameras and associated methods disclosed herein address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras. They provide an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW). The proposed solution distinguishes between video and still mode in

the processing flow and specifies the optical requirements and HW requirements. In addition, it provides an innovative optical design that enables a low TTL/EFL ratio using a specific lens curvature order.

Due to the large focal length, objects that are in front or behind the plane of focus appear very blurry, and a nice foreground-to-background contrast is achieved. However, it is difficult to create such a blur using a compact camera with a relatively short focal length and small aperture size, such as a cell-phone camera. In some embodiments, a dual-aperture zoom system disclosed herein can be used to capture a shallow DOF photo (shallow compared with a DOF of a Wide camera alone), by taking advantage of the longer focal length of the Tele lens. The reduced DOF effect provided by the longer Tele focal length can be further enhanced in the final image by fusing data from an image captured simultaneously with the Wide lens. Depending on the distance to the object, with the Tele lens focused on a subject of the photo, the Wide lens can be focused to a closer distance than the subject so that objects behind the subject appear very blurry. Once the two images are captured, information from the out-of-focus blurred background in the Wide image is fused with the original Tele image background information, providing a blurrier background and even shallower DOF.

In an embodiment there is provided a zoom digital camera comprising a Wide imaging section that includes a fixed focal length Wide lens with a Wide FOV, a Wide sensor and a Wide image signal processor (ISP), the Wide imaging section operative to provide Wide image data of an object or scene; a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, the Tele imaging section operative to provide Tele image data of the object or scene; and a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view (POV), and to provide without fusion continuous zoom video mode output images of the object or scene, a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, wherein the video output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

In an embodiment, the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses at high ZF secondary information from the Wide camera and uses at low ZF secondary information from the Tele camera. As used herein, "secondary information" refers to white balance gain, exposure time, analog gain and color correction matrix.

In a dual-aperture camera image plane, as seen by each sub-camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either sub-camera image or the shape or position of a combination thereof. If the output image retains the Wide image shape then it has the Wide perspective POV. If it retains the Wide camera position then it has the Wide position POV. The same applies for Tele images position and perspective. As used in this description, the perspective POV may be of the Wide or Tele sub-cameras, while the position POV may shift continuously between the Wide and Tele sub-cameras. In fused images, it is possible to register Tele image pixels to a matching pixel set within the Wide image pixels, in which case the output image will retain the Wide POV (“Wide fusion”). Alternatively, it is possible to register Wide image pixels to a matching pixel set within the Tele image pixels, in which case the output image will retain the Tele POV (“Tele fusion”). It is also possible to perform the registration after either sub-camera image is shifted, in which case the output image will retain the respective Wide or Tele perspective POV.

In an embodiment there is provided a method for obtaining zoom images of an object or scene in both still and video modes using a digital camera, the method comprising the steps of providing in the digital camera a Wide imaging section having a Wide lens with a Wide FOV, a Wide sensor and a Wide image signal processor (ISP), a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, and a camera controller operatively coupled to the Wide and Tele imaging sections; and configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view, and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, wherein the video mode output images are provided with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa, and wherein at the lower ZF value the output resolution is determined by the Wide sensor while at the higher ZF value the output resolution is determined by the Tele sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting examples of embodiments disclosed herein are described below with reference to figures attached hereto that are listed following this paragraph. The drawings and descriptions are meant to illuminate and clarify embodiments disclosed herein, and should not be considered limiting in any way.

FIG. 1A shows schematically a block diagram illustrating a dual-aperture zoom imaging system disclosed herein;

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A:

FIG. 2 shows an example of Wide sensor, Tele sensor and their respective FOVs;

FIG. 3 shows a schematically embodiment of CMOS sensor image grabbing vs. time;

FIG. 4 shows schematically a sensor time configuration which enables sharing one sensor interface using dual sensor zoom system;

FIG. 5 shows an embodiment of a method disclosed herein for acquiring a zoom image in capture mode;

FIG. 6 shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode;

FIG. 7 shows a graph illustrating an effective resolution zoom factor;

FIG. 8 shows one embodiment of a lens block in a thin camera disclosed herein;

FIG. 9 shows another embodiment of a lens block in a thin camera disclosed herein.

DETAILED DESCRIPTION

FIG. 1A shows schematically a block diagram illustrating an embodiment of a dual-aperture zoom imaging system (also referred to simply as “digital camera” or "camera") disclosed herein and numbered **100**. Camera **100** comprises a Wide imaging section (“sub-camera”) that includes a Wide lens block **102,** a Wide image sensor **104** and a Wide image processor **106.** Camera **100** further comprises a Tele imaging section (“sub-camera”) that includes a Tele lens block **108,** a Tele image sensor **110** and a Tele image processor **112**. The image sensors may be physically separate or may be part of a single larger image sensor. The

Wide sensor pixel size can be equal to or different from the Tele sensor pixel size. Camera **100** further comprises a camera fusion processing core (also referred to as "controller") **114** that includes a sensor control module **116**, a user control module **118,** a video processing module **126** and a capture processing module **128,** all operationally coupled to sensor control block **110**. User control module **118** comprises an operational mode function **120**, a region of interest (ROI) function **122** and a zoom factor (ZF) function **124**.

Sensor control module **116** is connected to the two sub-cameras and to the user control module **118** and used to choose, according to the zoom factor, which of the sensors is operational and to control the exposure mechanism and the sensor readout. Mode choice function **120** is used for choosing capture/video modes. ROI function **122** is used to choose a region of interest. As used herein, "ROI" is a user defined as a sub-region of the image that may be exemplarily 4% or less of the image area. The ROI is the region on which both sub-cameras are focused on. . Zoom factor function **124** is used to choose a zoom factor. Video processing module **126** is connected to mode choice function **120** and used for video processing. Still processing module **128** is connected to the mode choice function **120** and used for high image quality still mode images. The video processing module is applied when the user desires to shoot in video mode. The capture processing module is applied when the user wishes to shoot still pictures.

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A. Exemplary dimensions: Wide lens TTL = 4.2mm and EFL = 3.5mm; Tele lens TTL = 6mm and EFL = 7 mm; both Wide and Tele sensors 1/3 inch. External dimensions of Wide and Tele cameras: width (w) and length (l) = 8.5 mm and height (h) = 6.8 mm. Distance "d" between camera centers = 10mm.

Following is a detailed description and examples of different methods of use of camera **100.**

Design for continuous and smooth zoom in video mode

In an embodiment, in order to reach high quality continuous and smooth optical zooming in video camera mode while reaching real optical zoom using fixed focal length sub-cameras, the system is designed according to the following rules (Equations 1-3):

$$\text{Tan}\ (FOV_{Wide})/\text{Tan}\ (FOV_{Tele}) = PL_{Wide}/\ PL_{video} \qquad (1)$$

where Tan refers to "tangent", while FOV_{Wide} and FOV_{Tele} refer respectively to the Wide and

Tele lens fields of view (in degrees). As used herein, the FOV is measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition). PL_{Wide} and PL_{video} refer respectively to the "in-line" (i.e. in a line) number of Wide sensor pixels and in-line number of output video format pixels. The ratio PL_{Wide}/PL_{video} is called an "oversampling ratio". For example, in order to get full and continuous optical zoom experience with a 12Mp sensor (sensor dimensions 4000x3000) and a required 1080p (dimension 1920x1080) video format, the FOV ratio should be 4000/1920=2.083. Moreover, if the Wide lens FOV is given as $FOV_{Wide} = 37.5^0$, the required Tele lens FOV is 20.2^0 The zoom switching point is set according to the ratio between sensor pixels in-line and the number of pixels in-line in the video format and defined as:

$$Z_{switch}=PL_{Wide}/ PL_{video} \quad (2)$$

Maximum optical zoom is reached according to the following formula:

$$Z_{max}= \mathrm{Tan}\,(FOV_{Wide})/\mathrm{Tan}\,(FOV_{Tele}) * PL_{Tele}/ PL_{video} \quad (3)$$

For example: for the configuration defined above and assuming PL_{Tele}=4000 and PL_{video}= 1920, Z_{max}=4.35.

In an embodiment, the sensor control module has a setting that depends on the Wide and Tele FOVs and on a sensor oversampling ratio, the setting used in the configuration of each sensor. For example, when using a 4000x3000 sensor and when outputting a 1920x1080 image, the oversampling ratio is 4000/1920=2.0833.

In an embodiment, the Wide and Tele FOVs and the oversampling ratio satisfy the condition

$$0.8*PL_{Wide}/ PL_{video} < \mathrm{Tan}\,(FOV_{Wide})/\mathrm{Tan}\,(FOV_{Tele}) <1.2*PL_{Wide}/ PL_{video}. \quad (4)$$

Still mode operation/function

In still camera mode, the obtained image is fused from information obtained by both sub-cameras at all zoom levels, see FIG. 2, which shows a Wide sensor **202** and a Tele sensor **204** and their respective FOVs. Exemplarily, as shown, the Tele sensor FOV is half the Wide sensor FOV. The still camera mode processing includes two stages: (1) setting HW settings and configuration, where a first objective is to control the sensors in such a way that matching FOVs in both images (Tele and Wide) are scanned at the same time. A second objective is to control the relative exposures according to the lens properties. A third objective is to minimize the required bandwidth from both sensors for the ISPs; and (2) image processing that fuses the Wide and the Tele images to achieve optical zoom, improves SNR and provides wide dynamic range.

FIG. 3 shows image line numbers vs. time for an image section captured by CMOS sensors. A fused image is obtained by line (row) scans of each image. To prevent matching FOVs in both sensors to be scanned at different times, a particular configuration is applied by the camera controller on both image sensors while keeping the same frame rate. The difference in FOV between the sensors determines the relationship between the rolling shutter time and the vertical blanking time for each sensor. In the particular configuration, the scanning is synchronized such that the same points of the object in each view are obtained simultaneously.

Specifically with reference to FIG. 3 and according to an embodiment of a method disclosed herein, the configuration to synchronize the scanning includes: setting the Tele sensor vertical blanking time VB_{Tele} to equal the Wide sensor vertical blanking time VB_{Wide} plus half the Wide sensor rolling shutter time RST_{Wide}; setting the Tele and Wide sensor exposure times ET_{Tele} and ET_{Wide} to be equal or different; setting the Tele sensor rolling shutter time RST_{Tele} to be $0.5{*}RST_{Wide}$; and setting the frame rates of the two sensors to be equal. This procedure results in identical image pixels in the Tele and Wide sensor images being exposed at the same time

In another embodiment, the camera controller synchronizes the Wide and Tele sensors so that for both sensors the rolling shutter starts at the same time.

The exposure times applied to the two sensors could be different, for example in order to reach same image intensity using different F# and different pixel size for the Tele and Wide systems. In this case, the relative exposure time may be configured according to the formula below:

$$ET_{Tele}= ET_{Wide}\cdot(F\#_{Tele}/F\#_{Wide})^2 \cdot (\text{Pixel size}_{Wide}/\text{Pixel size}_{Tele})^2 \qquad (5)$$

Other exposure time ratios may be applied to achieve wide dynamic range and improved SNR. Fusing two images with different intensities will result in wide dynamic range image.

In more detail with reference to FIG. 3, in the first stage, after the user chooses a required zoom factor ZF, the sensor control module configures each sensor as follows:

1) Cropping index Wide sensor:

$Y_{Wide\ start} = 1/2\cdot PC_{Wide}(1-1/ZF)$

$Y_{Wide\ end} = 1/2 \cdot PC_{Wide}(1+1/ZF)$

where PC is the number of pixels in a column, and Y is the row number

2) Cropping index Tele sensor:

If $ZF > \text{Tan}(FOV_{Wide})/\text{Tan}(FOV_{Tele})$, then

$Y_{Tele\ start} = 1/2 \cdot PC_{Tele}(1-(1/ZF) \cdot \text{Tan}(FOV_{Tele})/\text{Tan}(FOV_{Wide}))$

$Y_{Tele\ end} = 1/2 \cdot PC_{Tele}(1+(1/ZF) \cdot \text{Tan}(FOV_{Tele})/\text{Tan}(FOV_{Wide}))$

If $ZF < \text{Tan}(FOV_{Wide})/\text{Tan}(FOV_{Tele})$, then

$Y_{Tele\ start} = 0$

$Y_{Tele\ end} = PC_{Tele}$

This will result in an exposure start time of the Tele sensor with a delay of (in numbers of lines, relative to the Wide sensor start time):

$$(1-ZF/((\text{Tan}(FOV_{Wide})/\text{Tan}(FOV_{Tele}))) \cdot 1/(2 \cdot FPS) \qquad (6)$$

where FPS is the sensor's frame per second configuration. In cases where $ZF > \text{Tan}(FOV_{Wide})/\text{Tan}(FOV_{Tele})$, no delay will be introduced between Tele and Wide exposure starting point. For example, for a case where $\text{Tan}(FOV_{Wide})/\text{Tan}(FOV_{Tele})=2$ and ZF=1, the Tele image first pixel is exposed $1/4 \cdot (1/FPS)$ second after the Wide image first pixel was exposed.

After applying the cropping according to the required zoom factor, the sensor rolling shutter time and the vertical blank should be configured in order to satisfy the equation to keep the same frame rate:

$$VB_{Wide}+RST_{Wide}= VB_{Tele}+RST_{Tele} \qquad (7)$$

FIG. 3 exemplifies Eq. (7). One way to satisfy Eq. (7) is to increase the RST_{Wide}. Controlling the RST_{Wide} may be done by changing the horizontal blanking (HB) of the Wide sensor. This will cause a delay between the data coming out from each row of the Wide sensor.

Generally, working with a dual-sensor system requires multiplying the bandwidth to the following block, for example the ISP. For example, using 12Mp working at 30fps, 10bit per pixel requires working at 3.6Gbit/sec. In this example, supporting this bandwidth requires 4 lanes from each sensor to the respective following ISP in the processing chain. Therefore, working with two sensors requires double bandwidth (7.2Gbit/sec) and 8 lanes connected to the respective following blocks. The bandwidth can be reduced by configuring and synchronizing the two sensors. Consequently, the number of lanes can be half that of a conventional configuration (3.6Gbit/sec).

FIG. 4 shows schematically a sensor time configuration that enables sharing one sensor interface using a dual-sensor zoom system, while fulfilling the conditions in the description of FIG. 3 above. For simplicity, assuming the Tele sensor image is magnified by a factor of 2 compared with the Wide sensor image, the Wide sensor horizontal blanking time HB_{Wide} is set to twice the Wide sensor line readout time. This causes a delay between output Wide lines. This delay time matches exactly the time needed to output two lines from the Tele sensor. After outputting two lines from the Tele sensor, the Tele sensor horizontal blanking time HB_{Tele} is set to be one Wide line readout time, so, while the Wide sensor outputs a row from the sensor, no data is being output from the Tele sensor. For this example, every 3rd line in the Tele sensor is delayed by an additional HB_{Tele}. In this delay time, one line from the Wide sensor is output from the dual-sensor system. After the sensor configuration stage, the data is sent in parallel or by using multiplexing into the processing section.

FIG. 5 shows an embodiment of a method disclosed herein for acquiring a zoom image in still mode. In ISP step **502**, the data of each sensor is transferred to the respective ISP component, which performs on the data various processes such as denoising, demosaicing, sharpening, scaling, etc, as known in the art. After the processing in step **502,** all following actions are performed in capture processing core **128**: in rectification step **504,** both Wide and Tele images are aligned to be on the epipolar line; in registration step **506**, mapping between the Wide and the Tele aligned images is performed to produce a registration map; in resampling step **508,** the Tele image is resampled according to the registration map, resulting in a re-sampled Tele image; in decision step **510**, the re-sampled Tele image and the Wide image are processed to detect errors in the registration and to provide a decision output. In more detail, in step **510,** the re-sampled Tele image data is compared with the Wide image data and if the comparison detects significant dissimilarities, an error is indicated. In this case, the Wide pixel values are chosen to be used in the output image. Then, in fusion step **512,** the decision output, re-sampled Tele image and the Wide image are fused into a single zoom image.

To reduce processing time and power, steps **506, 508, 510, 512** could be bypassed by not fusing the images in non-focused areas. In this case, all steps specified above should be applied on focused areas only. Since the Tele optical system will introduce shallower depth of field than the Wide optical system, defocused areas will suffer from lower contrast in the Tele system.

Zoom-in and Zoom-out in still camera mode

We define the following: TFOV = tan (camera FOV/2). "Low ZF" refers to all ZF that comply with ZF < Wide TFOV/Tele TFOV. "High ZF" refers to all ZF that comply with ZF > Wide TFOV/Tele TFOV. "ZFT" refers to a ZF that complies with ZF = Wide TFOV/Tele TFOV. In one embodiment, zoom-in and zoom-out in still mode is performed as follows:

Zoom-in: at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output. For the up-transfer ZF, the Tele image is shifted and corrected by global registration (GR) to achieve smooth transition. Then, the output is transformed to a Tele fusion output. For higher (than the up-transfer) ZF, the output is the Tele fusion output digitally zoomed.

Zoom-out: at high ZF down to slightly below ZFT, the output image is a digitally zoomed, Tele fusion output. For the down-transfer ZF, the Wide image is shifted and corrected by GR to achieve smooth transition. Then, the output is transformed to a Wide fusion output. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

In another embodiment, zoom-in and zoom-out in still mode is performed as follows:

Zoom-in: at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output. For the up-transfer ZF and above, the output image is the Tele fusion output.

Zoom-out: at high ZF down to slightly below ZFT, the output image is a digitally zoomed, Tele fusion output. For the down-transfer ZF and below, the output image is the Wide fusion output.

Video mode operation/function

Smooth transition

When a dual-aperture camera switches the camera output between sub-cameras or points of view, a user will normally see a "jump" (discontinuous) image change. However, a change in the zoom factor for the same camera and POV is viewed as a continuous change. A "smooth transition" is a transition between cameras or POVs that minimizes the jump effect. This may include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the sub-camera outputs is in many cases impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in a smooth transition as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

Zoom-in and Zoom-out in video mode

In video mode, sensor oversampling is used to enable continuous and smooth zoom experience. Processing is applied to eliminate the changes in the image during crossover from one sub-camera to the other. Zoom from 1 to Z_{switch} is performed using the Wide sensor only. From Z_{switch} and on, it is performed mainly by the Tele sensor. To prevent "jumps" (roughness in the image), switching to the Tele image is done using a zoom factor which is a bit higher (Z_{switch} +ΔZoom) than Z_{switch}. ΔZoom is determined according to the system's properties and is different for cases where zoom-in is applied and cases where zoom-out is applied ($\Delta Zoom_{in} \neq \Delta Zoom_{out}$). This is done to prevent residual jumps artifacts to be visible at a certain zoom factor. The switching between sensors, for an increasing zoom and for decreasing zoom, is done on a different zoom factor.

The zoom video mode operation includes two stages: (1) sensor control and configuration, and (2) image processing. In the range from 1 to Z_{switch}, only the Wide sensor is operational, hence, power can be supplied only to this sensor. Similar conditions hold for a Wide AF mechanism. From Z_{switch}+ΔZoom to Z_{max} only the Tele sensor is operational, hence, power is supplied only to this sensor. Similarly, only the Tele sensor is operational and power is supplied only to it for a Tele AF mechanism. Another option is that the Tele sensor is operational and the Wide sensor is working in low frame rate. From Z_{switch} to Z_{switch}+ΔZoom, both sensors are operational.

Zoom-in: at low ZF up to slightly above ZFT, the output image is the digitally zoomed, unchanged Wide camera output. For the up-transfer ZF, the output is a transformed Tele sub-camera output, where the transformation is performed by a global registration (GR) algorithm to achieve smooth transition. For higher (than the up-transfer), the output is the transfer ZF output digitally zoomed.

Zoom-out: at high ZF down to slightly below ZFT, the output image is the digitally zoomed transformed Tele camera output. For the down-transfer ZF, the output is a shifted Wide camera output, where the Wide shift correction is performed by the GR algorithm to achieve smooth transition, i.e. with no jump in the ROI region. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

FIG. 6 shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode for 3 different zoom factor (ZF) ranges: (a) ZF range = 1 : Z_{switch}; (b) ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$; and (c) Zoom factor range = Z_{switch} + $\Delta Zoom_{in}$: Z_{max}. The description is with reference to a graph of effective resolution vs. zoom value (FIG. 7). In step **602**, sensor control module **116** chooses (directs) the sensor (Wide, Tele or both) to be operational. Specifically, if the ZF range = 1:Z_{switch}, module **116** directs the Wide sensor to be operational and the Tele sensor to be non-operational. If the ZF range is Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, module **116** directs both sensors to be operational and the zoom image is generated from the Wide sensor. If the ZF range is Z_{switch} + $\Delta Zoom_{in}$: Z_{max}, module **116** directs the Wide sensor to be non-operational and the Tele sensor to be operational. After the sensor choice in step **602,** all following actions are performed in video processing core **126**. Optionally, in step **604,** color balance is calculated if two images are provided by the two sensors. Optionally yet, in step **606**, the calculated color balance is applied in one of the images (depending on the zoom factor). Further optionally, in step **608**, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient can be used to set an AF position in step **610**. In step **612**, an output of any of steps **602-608** is applied on one of the images (depending on the zoom factor) for image signal processing that may include denoising, demosaicing, sharpening, scaling, etc. In step **614**, the processed image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p). To avoid a transition point to be executed at the same ZF, $\Delta Zoom$ can change while zooming in and while zooming out. This will result in hysteresis in the sensor switching point.

In more detail, for ZF range 1 : Z_{switch}, for ZF < Z_{switch}, the Wide image data is transferred to the ISP in step **612** and resampled in step **614**. For ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, both sensors are operational and the zoom image is generated from the Wide sensor. The color balance is calculated for both images according to a given ROI. In addition, for a given ROI, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient is used to set an AF position. The transformation coefficient includes the translation between matching points in the two images. This translation can be measured in a number of pixels. Different translations will result in a different number of pixel movements between matching points in the images. This movement can be translated into depth and the depth can be translated into an AF position. This enables to set the AF position by only analyzing two images (Wide & Tele). The result is fast focusing.

Both color balance ratios and transformation coefficient are used in the ISP step. In parallel, the Wide image is processed to provide a processed image, followed by resampling. For ZF range = $Z_{switch} + \Delta Zoom_{in} : Z_{max}$ and for Zoom factor > $Z_{switch,} + \Delta Zoom_{in}$, the color balance calculated previously is now applied on the Tele image. The Tele image data is transferred to the ISP in step **612** and resampled in step **614**. To eliminate crossover artifacts and to enable smooth transition to the Tele image, the processed Tele image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p).

FIG. 7 shows the effective resolution as a function of the zoom factor for a zoom-in case and for a a zoom-out case $\Delta Zoom_{up}$ is set when we zoom in, and $\Delta Zoom_{down}$ is set when we zoom out. Setting $\Delta Zoom_{up}$ to be different from $\Delta Zoom_{down}$ will result in transition between the sensors to be performed at different zoom factor ("hysteresis") when zoom-in is used and when zoom-out is used. This hysteresis phenomenon in the video mode results in smooth continuous zoom experience.

Optical Design

Additional optical design considerations were taken into account to enable reaching optical zoom resolution using small total track length (TTL). These considerations refer to the Tele lens. In an embodiment, the camera is "thin" (see also FIG. 1B) in the sense that is has an optical path of less than 9mm and a thickness/focal length (FP) ratio smaller than about 0.85. Exemplarily, as shown in FIG. 8, such a thin camera has a lens block that includes (along an optical axis starting from an object) five lenses: a first lens element **802** with positive power and two lenses **804** and **806** and with negative power, a fourth lens **808** with positive power and a fifth lens **810** with negative power. In the embodiment of FIG. 8, the EFL is 7 mm, the TTL is 4.7 mm, f = 6.12 and FOV = 20^0. Thus the Tele lens TTL/EFL ratio is smaller than 0.9. In other embodiments, the Tele lens TTL/EFL ratio may be smaller than 1.

In another embodiment of a lens block in a thin camera, shown in FIG. 9, the camera has a lens block that includes (along an optical axis starting from an object) a first lens element **902** with positive power a second lens element **904** with negative power, a third lens element with positive power **906** and a fourth lens element with negative power **908**, and a fifth filed lens element **910** with positive or negative power. In this embodiment, f =7.14, F# = 3.5, TTL = 5.8mm and FOV = 22.7^0.

In conclusion, dual aperture optical zoom digital cameras and associate methods disclosed herein reduce the amount of processing resources, lower frame rate requirements, reduce power consumption, remove parallax artifacts and provide continuous focus (or provide loss of focus) when changing from Wide to Tele in video mode. They provide a dramatic reduction of the disparity range and avoid false registration in capture mode. They reduce image intensity differences and enable work with a single sensor bandwidth instead of two, as in known cameras.

All patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present disclosure.

While this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of the embodiments and methods will be apparent to those skilled in the art. The disclosure is to be understood as not limited by the specific embodiments described herein, but only by the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV), a Wide sensor and a Wide image signal processor (ISP), the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution;

wherein the video output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

2. The camera of claim 1, wherein the controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

3. The camera of claim 2, wherein the user inputs include a zoom factor, a camera mode and a region of interest (ROI).

4. The camera of claim 2, wherein the sensor control module has a setting that depends on the Wide and Tele fields of view and on a sensor oversampling ratio, the setting used in the configuration of each sensor.

5. The camera of claim 4, wherein the Wide and Tele FOVs and the sensor oversampling ratio satisfy the condition $0.8*PL_{Wide}/ PL_{video} < \tan(FOV_{Wide})/\tan(FOV_{Tele}) < 1.2*PL_{Wide}/ PL_{video}$, wherein PL_{Wide} is an in-line number of Wide sensor pixels and wherein PL_{video} is an in-line number of output video format pixels.

6. The camera of claim 1, wherein the Tele lens includes a ratio of total length (TTL)/effective focal length (EFL) smaller than 1.

7. The camera of claim 5 wherein each lens includes five lens elements.

8. The camera of claim 6, wherein the five elements have, in order from the object side, positive-negative-negative-positive-negative powers.

9. The camera of claim 6, wherein the five elements have, in order from the object side, positive-negative-positive-negative and positive or negative powers.

10. The camera of claim 1, wherein the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses information either from the Wide sensor or from the Tele sensor.

11. The camera of claim 1,wherein the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses at high ZF secondary information from the Wide camera and uses at low ZF secondary information from the Tele camera.

12. A method for obtaining zoom images of an object or scene in both still and video modes using a digital camera, the method comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV), a Wide sensor and a Wide image signal processor (ISP), a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV, a Tele sensor and a Tele ISP, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view, and to provide without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, wherein the video mode output images are provided with a smooth transition when switching between a lower zoom factor (ZF) value and a higher ZF value or vice versa, and wherein at the lower ZF value the output resolution is determined by the Wide sensor while at the higher ZF value the output resolution is determined by the Tele sensor.

13. The method of claim 12, wherein the step of configuring the camera controller to provide without fusion continuous zoom video mode output images of the object or scene includes configuring each sensor with a setting that depends on the Wide and Tele FOVs and on a sensor oversampling ratio.

14. The method of claim 13, wherein the Wide and Tele FOVs and the oversampling ratio satisfy the condition $0.8*PL_{WIDE}/ PL_{video} < \text{Tan} (FOV_{Wide})/\text{Tan} (FOV_{Tele}) <1.2*PL_{Wide}/ PL_{video}$, wherein PL_{Wide} is an inline number of Wide sensor pixels and PL_{video} is an in-line number of output video format pixels.

15. The method of claim 12, wherein the step of configuring the camera controller to provide without fusion continuous zoom video mode output images of the object or scene includes performing a registration between the Wide and Tele images to output a transformation coefficient and using the transformation coefficient to set an autofocus position.

16. The method of claim 12, wherein the smooth transition is obtained when zooming-in by switching between a lower ZF factor and a higher ZF factor at a first ZF value, and is obtained when zooming-out by switching between a higher ZF factor and a lower ZF factor at a second ZF value different from the first ZF value.

17. The method of claim 12, wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

18. The method of claim 12, wherein each lens has a different F number and wherein the step of configuring the camera controller to combine in still mode at least some of the Wide

and Tele image data to provide a fused output image includes configuring the camera controller to set an exposure time based on a ratio of the different F numbers.

19. The method of claim 12, wherein the step of wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to set two images with different intensities to provide a wide dynamic range image.

20. The method of claim 12, wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the two sensors to obtain the fused image using a single sensor bandwidth.

21. The method of claim 12, wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to synchronize the Wide and Tele sensors to force an overlap area in the object image to be exposed at the same time, wherein the synchronizing includes:

i. setting a Tele sensor vertical blanking time VB_{Tele} to equal a Wide sensor vertical blanking time VB_{Wide} plus half a Wide sensor rolling shutter time RST_{Wide},

ii. setting respective Tele and Wide sensor exposure times ET_{Tele} and ET_{Wide} to be equal,

iii. setting a Tele sensor rolling shutter time RST_{tele} to be $RST_{Wide}/2$, and

iv. setting frame rates of the two sensors to be equal.

22. The method of claim 12, wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to synchronize the Wide and Tele sensors to force the two sensors to start exposure at the same time.

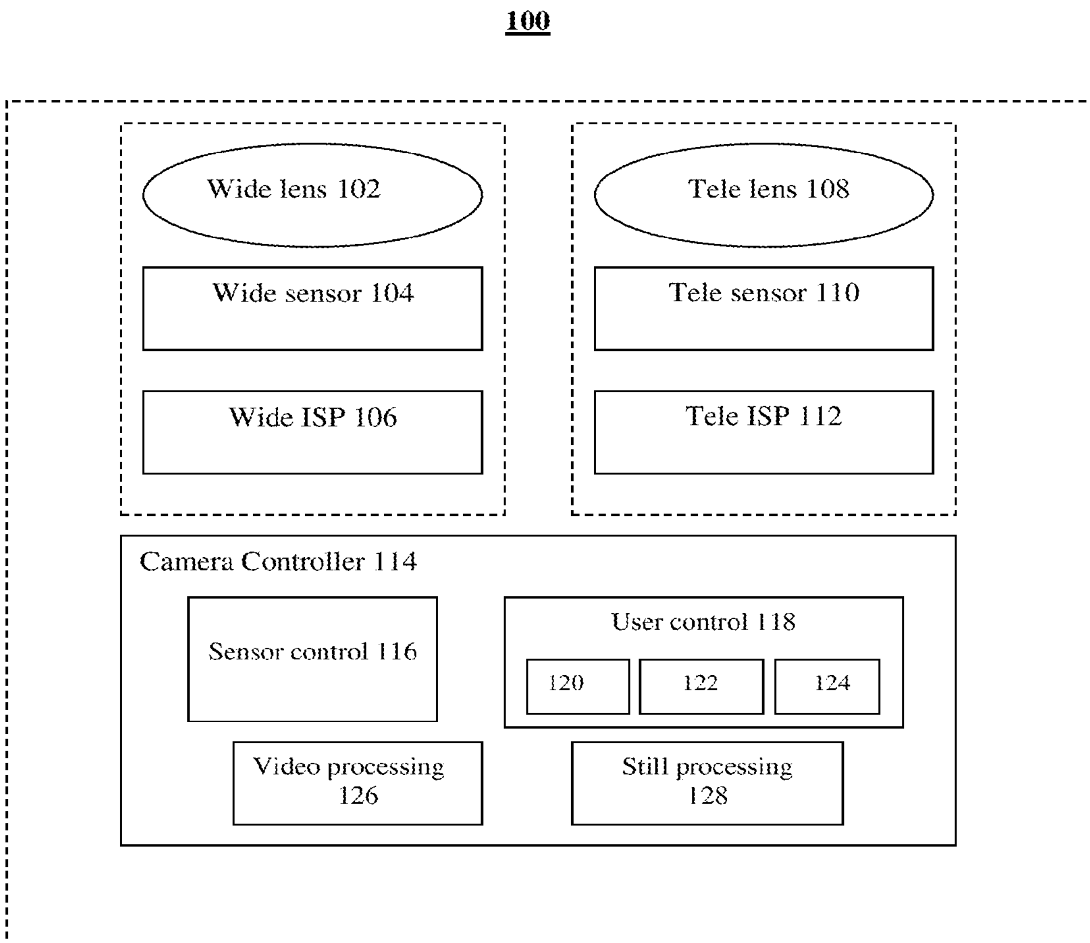
100
Wide lens 102
Tele lens 108
Wide sensor 104
Tele sensor 110
Wide ISP 106
Tele ISP 112
Camera Controller 114
Sensor control 116
User control 118
120
122
124
Video processing 126
Still processing 128

FIG. 1A

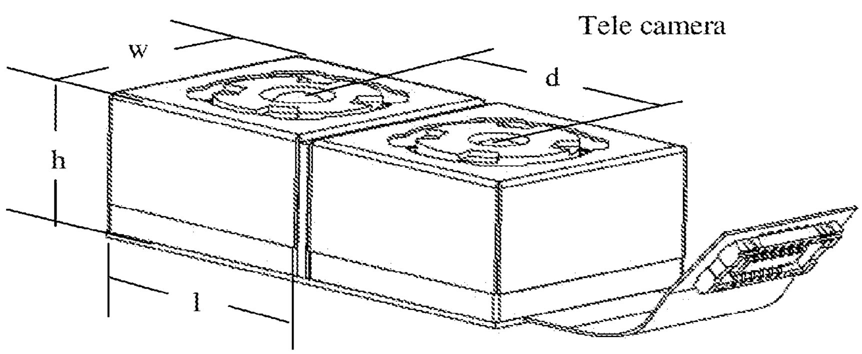
Tele camera
w
d
h
l

FIG. 1B

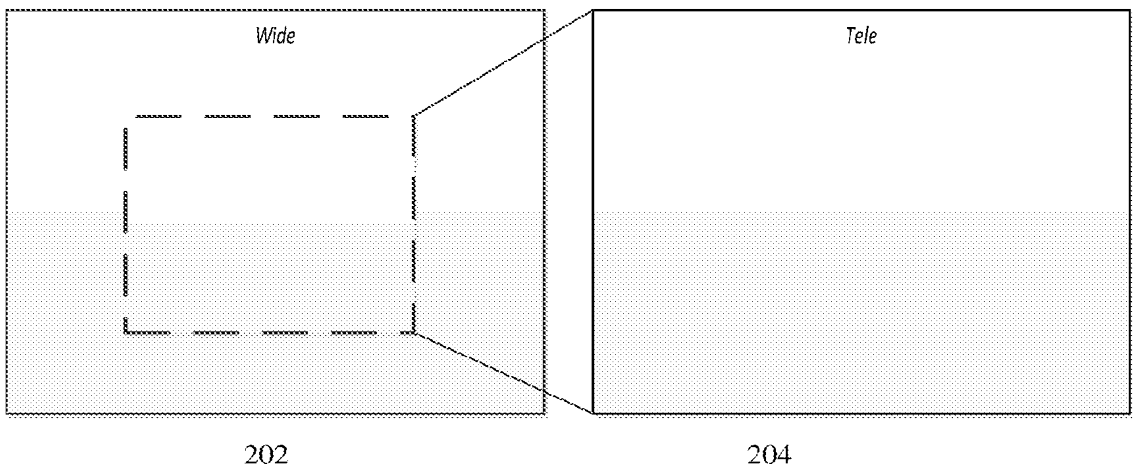

FIG. 2

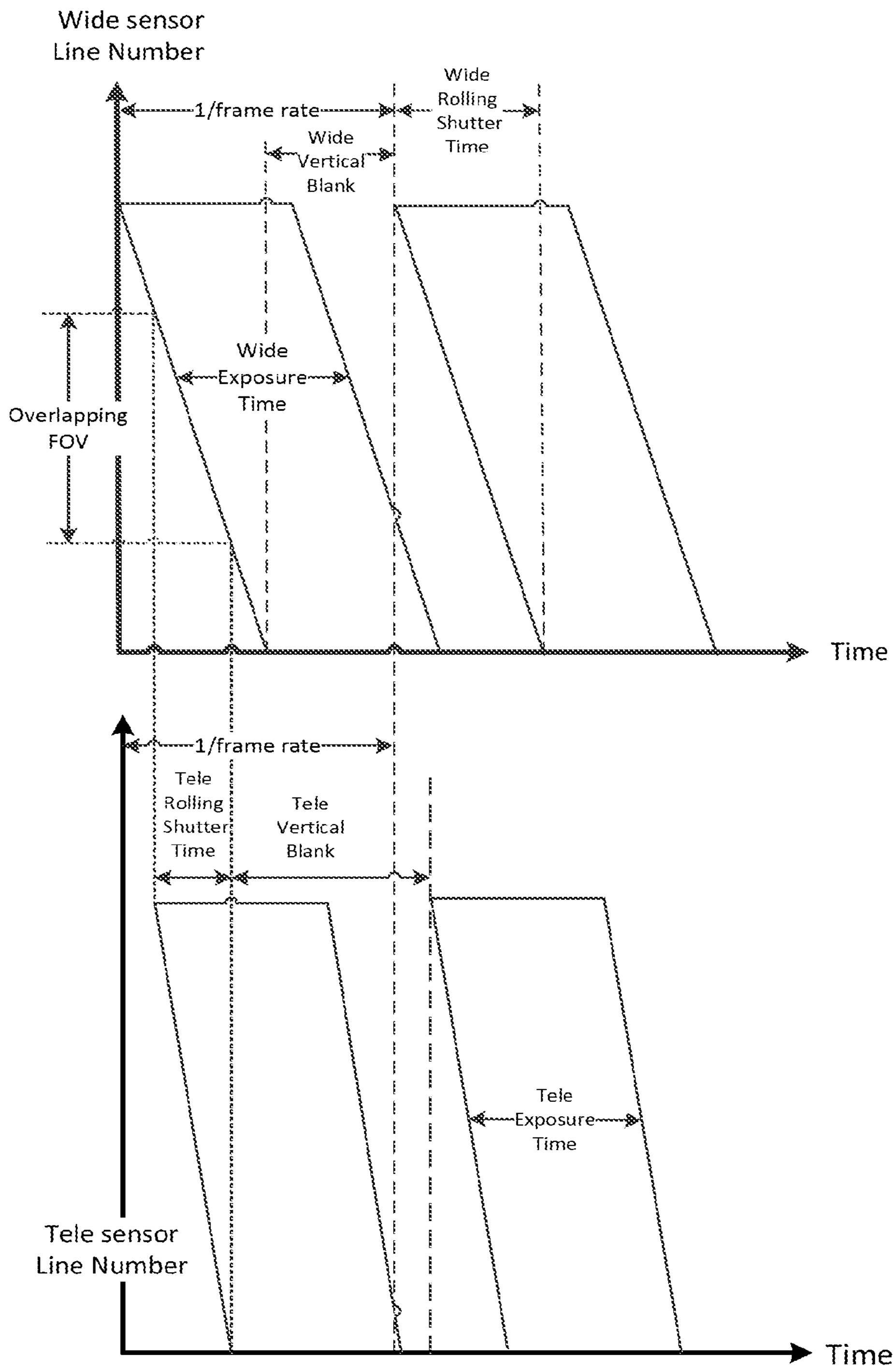
Wide sensor
Line Number
1/frame rate
Wide
Rolling
Shutter
Time
Wide
Vertical
Blank
Wide
Exposure
Time
Overlapping
FOV
Time
1/frame rate
Tele
Rolling
Shutter
Time
Tele
Vertical
Blank
Tele
Exposure
Time
Tele sensor
Line Number
Time

FIG. 3

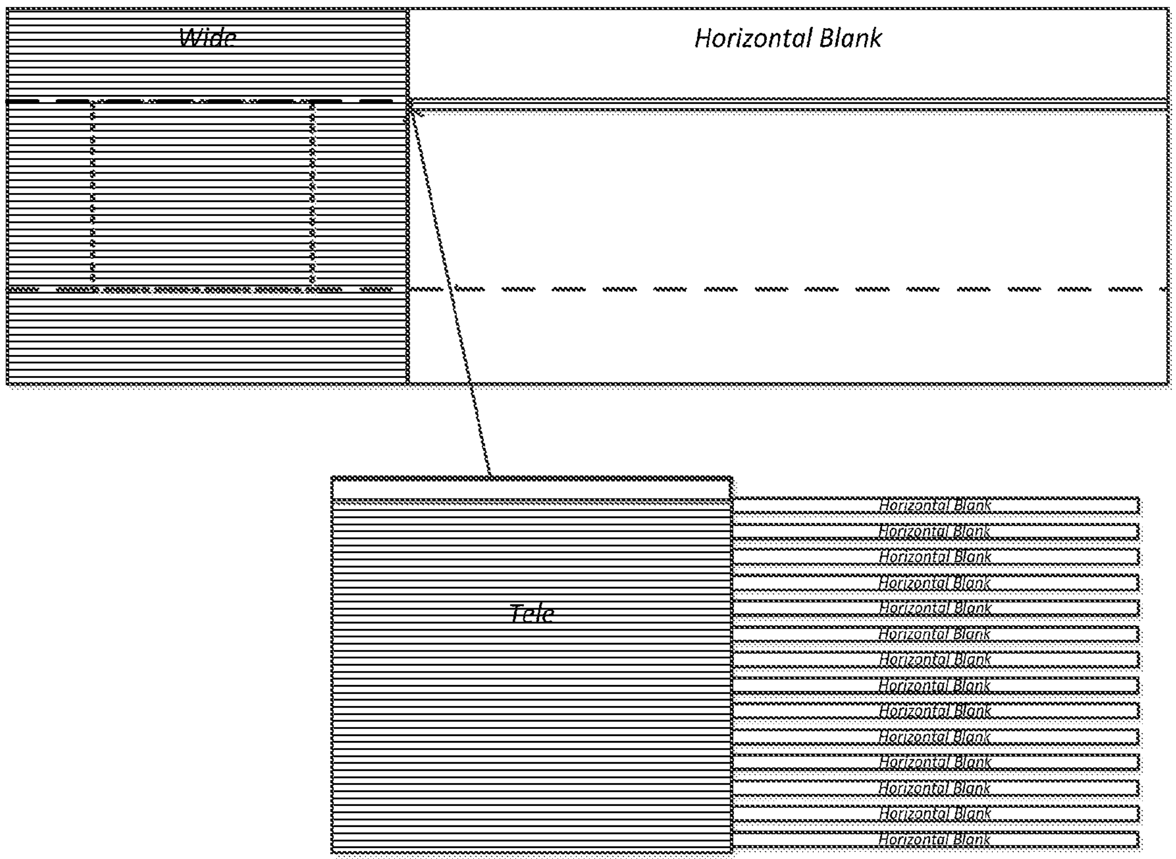
Wide
Horizontal Blank
Tele
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank
Horizontal Blank

FIG. 4

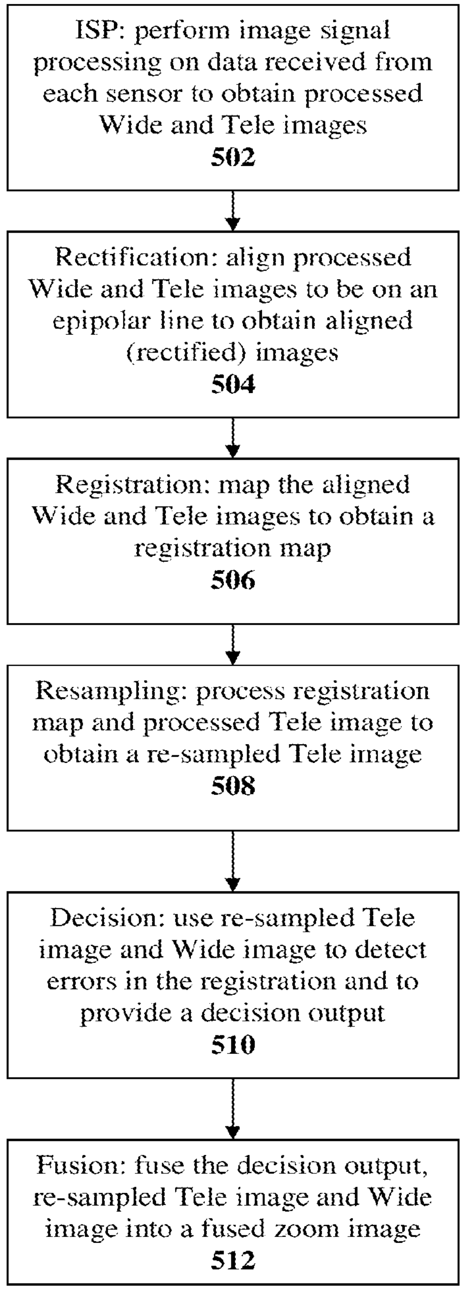
ISP: perform image signal processing on data received from each sensor to obtain processed Wide and Tele images
502
Rectification: align processed Wide and Tele images to be on an epipolar line to obtain aligned (rectified) images
504
Registration: map the aligned Wide and Tele images to obtain a registration map
506
Resampling: process registration map and processed Tele image to obtain a re-sampled Tele image
508
Decision: use re-sampled Tele image and Wide image to detect errors in the registration and to provide a decision output
510
Fusion: fuse the decision output, re-sampled Tele image and Wide image into a fused zoom image
512

FIG. 5

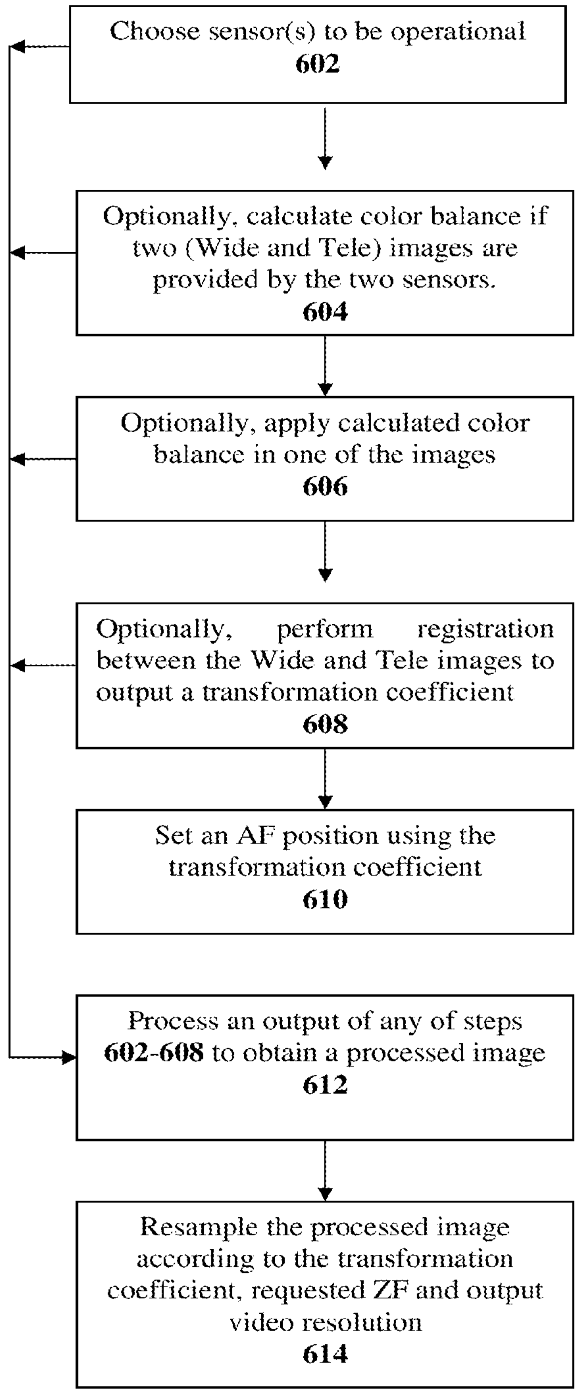
Choose sensor(s) to be operational
602
Optionally, calculate color balance if two (Wide and Tele) images are provided by the two sensors.
604
Optionally, apply calculated color balance in one of the images
606
Optionally, perform registration between the Wide and Tele images to output a transformation coefficient
608
Set an AF position using the transformation coefficient
610
Process an output of any of steps 602-608 to obtain a processed image
612
Resample the processed image according to the transformation coefficient, requested ZF and output video resolution
614

FIG. 6

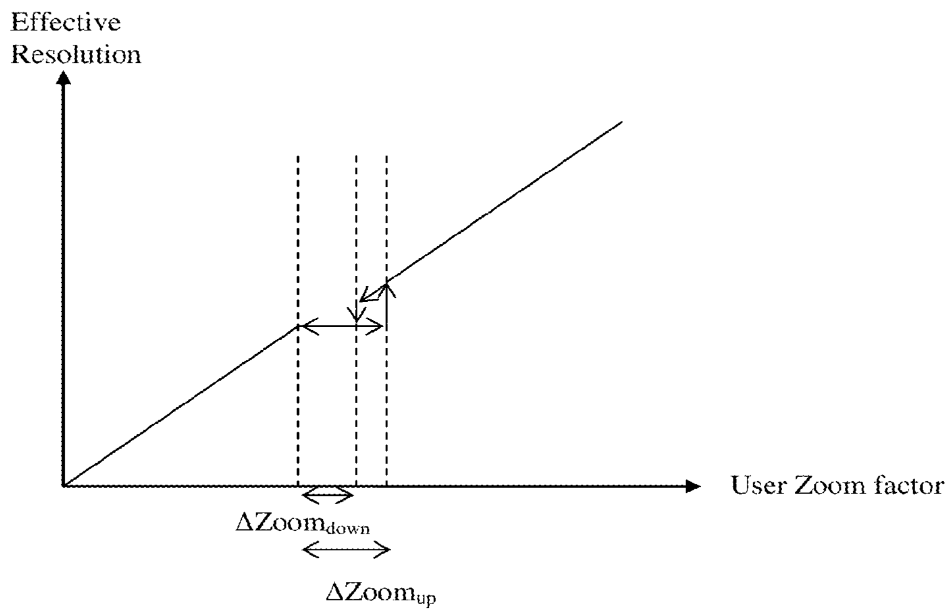
Effective
Resolution
User Zoom factor
$\Delta Zoom_{down}$
$\Delta Zoom_{up}$

FIG. 7

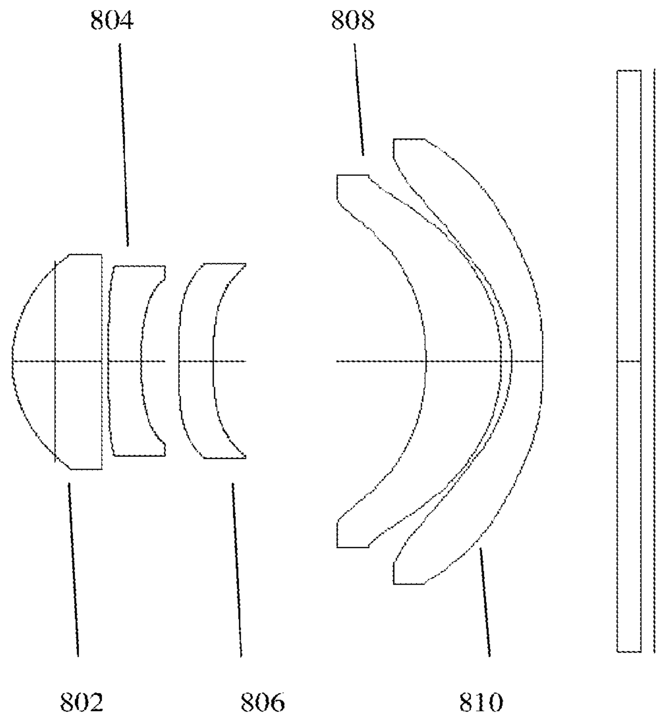

FIG. 8

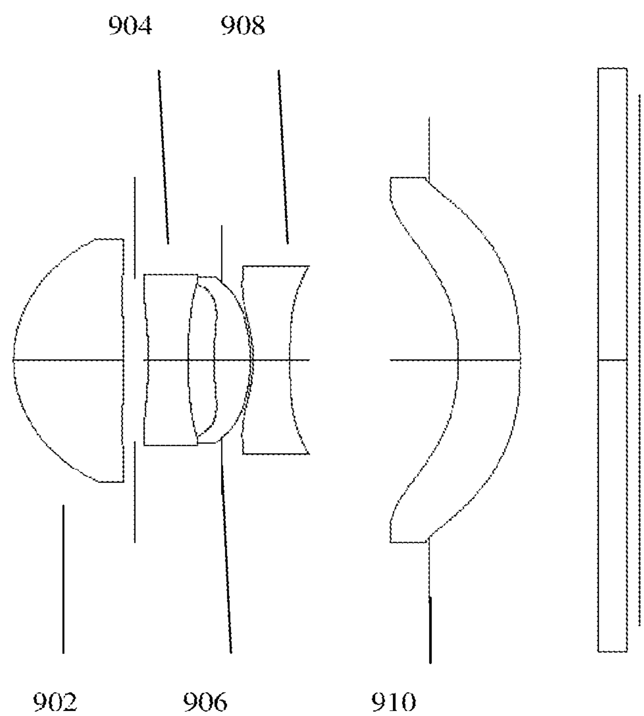

FIG. 9

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To: GAL SHABTAY
NATHAN & ASSOCIATES PATENT AGENTS LTD.
P.O. BOX 10178
TEL-AVIV, 611010
ISRAEL

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT AND THE WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY, OR THE DECLARATION

(PCT Rule 44.1)

	Date of mailing *(day/month/year)*
Applicant's or agent's file reference COREPH-0159	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/IB2016/053803	International filing date *(day/month/year)* 26 June 2016
Applicant COREPHOTONICS LTD.	

1. ☒ The applicant is hereby notified that the international search report and the written opinion of the International Searching Authority have been established and are transmitted herewith.

   Filing of amendments and statement under Article 19:
   The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

   When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

   How? Directly to the International Bureau of WIPO preferably through ePCT or on paper to, 34 chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: +41 22 338 82 70

   For more detailed instructions, see *PCT Applicant's Guide*, International Phase, paragraphs 9.004 – 9.011.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect and the written opinion of the International Searching Authority are transmitted herewith.

3. ☐ **With regard to any protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

   ☐ the protest together with the decision thereon has been transmitted to the International Bureau together with any request to forward the texts of both the protest and the decision thereon to the designated Offices.

   ☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

   The applicant may **submit comments on an informal basis on the written opinion of the International Searching Authority** to the International Bureau. These comments will be made available to the public after international publication. The International Bureau will send a copy of such comments to all designated Offices unless an international preliminary examination report has been or is to be established.

   Shortly after the expiration of **18 months from the priority date, the international application will be published** by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau before the completion of the technical preparations for international publication (Rules 90*bis*.1 and 90*bis*.3).

   Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise, the applicant must, **within 20 months** from the priority date, perform the prescribed acts for **entry into the national phase** before those designated Offices. In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months. For details about the applicable time limits, Office by Office, see www.wipo.int/pct/en/texts/time_limits.html and the *PCT Applicant's Guide*, National Chapters.

   Within 19 months from the priority date, the applicant may request that a supplementary international search be carried out by a different International Searching Authority that offers this service (Rule 45*bis*.1). The procedure for requesting supplementary international search is described in the *PCT Applicant's Guide*, International Phase, paragraphs 8.006-8.032.

Name and mailing address of the ISA/	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450	Blaine R. Copenheaver
Facsimile No. 571-273-8300	Telephone No. PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/220 (July 2014)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/053803

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04N 5/262; G02B 15/00; G06T 5/50 (2016.01)
CPC - H04N 5/262; G02B 15/00; G06T 5/50 (2016.08)
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC - G02B 15/00; G06T 5/50; H04N 5/262
CPC - G02B 15/00; G06T 5/50; H04N 5/262

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 348/218.1; 348/240.2; 348/240.3; 359/691 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Patbase, Google Patents, Google
Search terms used: dual aperture, tele, wide, no-switching criterion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2014/199338 A2 (COREPHOTONICS LTD.) 18 December 2014 (18.12.2014) entire document	1-21
Y	US 2003/0179303 A1 (BITTNER) 25 September 2003 (25.09.2003) entire document	1-21
Y	US 8,401,276 B1 (CHOE et al) 19 March 2013 (19.03.2013) entire document	3, 15
A	US 2009/0102950 A1 (AHISKA) 23 April 2009 (23.04.2009) entire document	1-21
A	US 2008/0030592 A1 (BORDER et al) 07 February 2008 (07.02.2008) entire document	1-21
A	US 6,104,432 A (NAKAMURA et al) 15 August 2000 (15.08.2000) entire document	1-21
A	US 5,710,670 A (OHNO) 20 January 1998 (20.01.1998) entire document	1-21

☐ Further documents are listed in the continuation of Box C.　☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 October 2016	26 OCT 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (January 2015)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: GAL SHABTAY
NATHAN & ASSOCIATES PATENT AGENTS LTD.
P.O. BOX 10178
TEL-AVIV, 611010
ISRAEL

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	26 OCT 2016
Applicant's or agent's file reference COREPH-0159	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/IB2016/053803	26 June 2016	13 August 2015

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H04N 5/262; G02B 15/00; G06T 5/50 (2016.01)
CPC - H04N 5/262; G02B 15/00; G06T 5/50 (2016.08)

Applicant COREPHOTONICS LTD.

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300	05 October 2016	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2016/053803

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [x] the international application in the language in which it was filed.
   - [ ] a translation of the international application into ____________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
   - a. [ ] forming part of the international application as filed:
     - [ ] in the form of an Annex C/ST.25 text file.
     - [ ] on paper or in the form of an image file.
   - b. [ ] furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
   - c. [ ] furnished subsequent to the international filing date for the purposes of international search only:
     - [ ] in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
     - [ ] on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (January 2015)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/IB2016/053803

Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-21	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-21	NO
Industrial applicability (IA)	Claims	1-21	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1, 2, 4-14, and 16-21 lack an inventive step under PCT Article 33(3) as being obvious over Corephotonics Ltd. (hereinafter Corephotonics) in view of Bittner.

Regarding Claim 1, Corephotonics discloses a zoom digital camera (abstract) comprising: a) a Wide imaging section (camera 100 comprises a wide imaging section, page 7, lines 28-34; wide imaging section, page 5, lines 17-34) that includes a fixed focal length Wide lens with a Wide field of view (wide lens block 102, page 7, lines 28-34; wide imaging section that includes a fixed focal length Wide lens with a Wide FOV, page 5, lines 17-34) and a Wide sensor (wide image sensor 104, page 7, lines 28-34; a Wide sensor, page 5, lines 17-34), the Wide imaging section operative to provide Wide image data of an object or scene (fig. 1A shows arrangement of camera 100 with wide lens 102, wide sensor 104, wide ISP 106; the Wide imaging section operative to provide Wide image data of an object or scene, page 5, lines 17-34); b) a Tele imaging section (camera 100 further comprises a Tele imaging section, page 7, lines 28-34; a Tele imaging section, page 5, lines 17-34) that includes a fixed focal length Tele lens with a Tele FOV (Tele lens block 108, page 7, lines 28-34; a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV, page 5, lines 17-34) that is narrower than the Wide FOV (as shown, the Tele sensor FOV is half the Wide sensor FOV, page 9, lines 30-36; a Tele FOV that is narrower than the Wide FOV, page 5, lines 17-34) and a Tele sensor (Tele image sensor 110, page 7, lines 28-34; a Tele sensor, page 5, lines 17-34), the Tele imaging section operative to provide Tele image data of the object or scene (fig. 1A shows arrangement of camera 100 with Tele lens 108, Tele sensor 110, Tele ISP 112; the Tele imaging section operative to provide Tele image data of the object or scene, page 5, lines 17-34); and c) a camera controller (camera 100 further comprises a camera fusion processing core, also referred to as controller, 114 that includes a sensor control module 116, user control module 118, video processing module 126, and capture processing module 128, page 8, lines 1-6; a camera controller, page 5, lines 17-34) operatively coupled to the Wide and Tele imaging sections (controller 114 is operationally coupled to sensor control block 110, page 8, lines 1-6; a camera controller operatively coupled to the Wide and Tele imaging sections, page 5, lines 17-34), the camera controller configured to evaluate a criterion determined by inputs from both Wide and Tele image data (the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view to provide without fusion continuous zoom video mode output images of the object or scene, page 5, lines 17-34), and, if the criterion is fulfilled, to output a zoom video output image that includes Wide image data in a zoom-in operation between a lower zoom factor value and a higher ZF value (wherein the video output images are provided with a smooth transition when switching between a lower zoom factor and a higher zoom factor value, page 5, lines 17-34; the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses a high ZF secondary information from the Wide camera and uses a low ZF secondary information from the Tele camera, page 6, lines 2-7); but lacks the explicit teaching of a no-switching criterion; zoom video output image that includes only Wide image data in a zoom-in operation. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]); zoom video output image (to capture the scene, the user actuates an image capture button 65 and the processor 40 causes the opto-digitally enhanced scene to be stored in non-volatile memory 45, para. 23) that includes only Wide image data in a zoom-in operation (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [before switching to normal lens 25, wide angle lens is digitally zoomed by processor 40 and the image that is output is from wide-angle lens in a zoom-in operation]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the zoom video output image that includes only Wide image data in a zoom-in operation of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16).

Regarding Claim 13, Corephotonics discloses a method (method, page 4, lines 31-34; claim 12) for obtaining zoom images of an object or scene using a digital camera (abstract), comprising the steps of: a) providing in the digital camera a Wide imaging section (camera 100 comprises a wide imaging section, page 7, lines 28-34; wide imaging section, page 5, lines 17-34) having a Wide lens with a Wide field of view (wide lens block 102, page 7, lines 28-34; wide imaging section that includes a fixed focal length Wide lens with a Wide FOV, page 5, lines 17-34) and a Wide sensor (wide image sensor 104, page 7, lines 28-34; a Wide sensor, page 5, lines 17-34), a Tele imaging section

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/IB2016/053803

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
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(camera 100 further comprises a Tele imaging section, page 7, lines 28-34; a Tele imaging section, page 5, lines 17-34) having a Tele lens with a Tele FOV (Tele lens block 108, page 7, lines 28-34; a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV, page 5, lines 17-34) that is narrower than the Wide FOV (as shown, the Tele sensor FOV is half the Wide sensor FOV, page 9, lines 30-36; a Tele FOV that is narrower than the Wide FOV, page 5, lines 17-34) and a Tele sensor (Tele image sensor 110, page 7, lines 28-34; a Tele sensor, page 5, lines 17-34), and a camera controller (camera 100 further comprises a camera fusion processing core, also referred to as controller, 114 that includes a sensor control module 116, user control module 118, video processing module 126, and capture processing module 128, page 8, lines 1-6; a camera controller, page 5, lines 17-34) operatively coupled to the Wide and Tele imaging sections (controller 114 is operationally coupled to sensor control block 110, page 8, lines 1-6; a camera controller operatively coupled to the Wide and Tele imaging sections, page 5, lines 17-34); and b) configuring the camera controller to evaluate a criterion determined by inputs from both Wide and Tele image data (the camera controller configured to combine in still mode at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view to provide without fusion continuous zoom video mode output images of the object or scene, page 5, lines 17-34), and, if the criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value (wherein the video output images are provided with a smooth transition when switching between a lower zoom factor and a higher zoom factor value, page 5, lines 17-34; the camera controller configuration to provide video output images with a smooth transition when switching between a lower ZF value and a higher ZF value or vice versa includes a configuration that uses a high ZF secondary information from the Wide camera and uses a low ZF secondary information from the Tele camera, page 6, lines 2-7); but lacks the explicit teaching of a no-switching criterion. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the zoom video output image that includes only Wide image data in a zoom-in operation of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16).

Regarding Claims 2, 14, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, and further teaches a shift between the Wide and Tele images calculated by global registration (at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output; for the up-transfer ZF, the Tele image is shifted and corrected by global registration to achieve smooth transition, page 13, lines 10-14); but lacks the teaching wherein the no-switching criterion includes a shift being greater than a first threshold. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]) includes a shift being greater than a first threshold (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [switch happens at predetermined threshold]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the no-switching criterion of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16).

Regarding Claims 4, 16, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, but lacks the teaching wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]) includes an effective resolution of a first zoom being lower than an effective resolution of a second zoom (zooming is accomplished without the degradation that could occur at high powers of digital zoom, para. 7). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the zoom video output image that includes only Wide image data in a zoom-in operation of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/IB2016/053803

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In case **the space in any of the preceding boxes is not sufficient.**
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Regarding Claims 5, 17, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, and further teaches a criterion includes a number of corresponding features in the Wide and Tele images (the sensor control module has a setting that depends on the Wide and Tele fields of view, claim 4; claim 10, 11); but lacks the teaching wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the no-switching criterion of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16). Modified Corephotonics lacks the explicit teaching of features being smaller than a third threshold. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to have the no-switching criterion include a number of corresponding features in the Wide and Tele images that are smaller than a third threshold, since, where the prior art has shown computations that use settings dependent upon information from the field of view, discovering the optimum or workable ranges involves only routine skill in the art. The motivation would have been to allow a desired amount or level of accuracy, smoothness, scale, or resolution, as was known in the optical or camera arts.

Regarding Claims 6, 18, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, and further teaches a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera (configuring the camera controller to synchronize the Wide and Tele sensors to force an overlap area in the object image to be exposed at the same time, claim 21; page 4, lines 22-30; performing a registration between the Wide and Tele images to output a transformation coefficient and using the transformation coefficient to set an autofocus position, claim 15; [to calculate autofocus position, camera needs to calculate distance of objects in Wide, Tele images]); but lacks the teaching of the no-switching criterion; closer to the camera than a first threshold distance. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the no-switching cirterion of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16). Modified Corephotonics lacks the explicit teaching of closer to the camera than a first threshold distance. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to have the no-switching criterion include a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance, since, where the prior art has shown computations that use settings dependent upon information from the field of view, discovering the optimum or workable ranges involves only routine skill in the art. The motivation would have been to allow a desired amount or level of accuracy, smoothness, scale, or resolution, as was known in the optical or camera arts.

Regarding Claims 7, 19, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, and further teaches some of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther (configuring the camera controller to synchronize the Wide and Tele sensors to force an overlap area in the object image to be exposed at the same time, claim 21; page 4, lines 22-30; performing a registration between the Wide and Tele images to output a transformation coefficient and using the transformation coefficient to set an autofocus position, claim 15; [to calculate autofocus position, camera needs to calculate distance of objects in Wide, Tele images]); but lacks the teaching of the no-switching criterion; closer than a second threshold distance; farther than a third distance threshold. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the no-switching cirterion of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16). Modified Corephotonics lacks the explicit teaching of closer than a second threshold distance; farther than a third distance threshold. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to have the no-switching criterion include some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold, since, where the prior art has shown computations that use settings dependent upon information from the field of view, discovering the optimum or workable ranges involves only routine skill in the art. The motivation would have been to allow a desired amount or level of accuracy, smoothness, scale, or resolution, as was known in the optical or camera arts.

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.

PCT/IB2016/053803

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
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Regarding Claim 8, Corephotonics discloses the camera of claim 1, wherein the camera controller includes a user control module (user control module 118, page 8, lines 1-6) for receiving user inputs (user zoom factor request, page 4, lines 22-30) and a sensor control module (image signal processor, page 4, lines 1-17; sensor control module 116, page 8, lines 7-18) for configuring each sensor to acquire the Wide and Tele image data based on the user inputs (processing is applied on the two images to fuse and output one fused image in still mode; the fused image is processed according to a user zoom factor request, page 4, lines 22-30; sensor control module 116 is connected to the two sub-cameras and to the user control module 118 and used to choose which of the sensors is operational and to control the exposure mechanism and sensor readout, page 8, lines 7-18).

Regarding Claim 9, Corephotonics discloses the camera of claim 8, wherein the user inputs include a zoom factor (user zoom factor request, page 4, lines 22-30), a camera mode and a region of interest (the user inputs include a zoom factor, a camera mode, and a region of interest, claim 3; camera mode, page 8, lines 29-31; region of interest function 122, page 8, lines 1-18).

Regarding Claim 10, Corephotonics discloses the camera of claim 1, teaches the Tele lens includes a ratio of total track length (TTL = 6mm, page 8, lines 19-23) to effective focal length (EFL = 7mm, page 8, lines 19-23) smaller than 1 (page 8, lines 19-23; claim 6; [6/7 is less than 1]).

Regarding Claim 11, Corephotonics discloses the camera of claim 1, wherein, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor (wherein the video output images are provided with a smooth transition when switching between a lower zoom factor value and a higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor and wherein at the higher ZF value the output resolution is determined by the Tele sensor, claim 1).

Regarding Claims 12, 20, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view (wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas, claim 17).

Regarding Claim 21, modified Corephotonics discloses the method of claim 13, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas (wherein the step of configuring the camera controller to combine in still mode at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas, claim 17).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY	International application No. PCT/IB2016/053803

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Claims 3 and 15 lack an inventive step under PCT Article 33(3) as being obvious over Corephotonics Ltd. (hereinafter Corephotonics) in view of Bittner and Choe et al. (hereinafter Choe).

~~Regarding Claims 3, 15, Corephotonics discloses the camera of claim 1, the method of claim 13, respectively, and further teaches a~~ disparity range (they provide a dramatic reduction of the disparity range, page 17, lines 7-13); global registration (global registration, page 13, lines 10-14; performing a registration between the Wide and Tele images to output a transformation coefficient, claim 15); but lacks the teaching wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold. Bittner is in the field of image capture devices which perform a combination of digital and optical zoom techniques (abstract) and teaches a no-switching criterion (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [prior to activation of switching element 50, wide-angle lens 20 undergoes a zooming operation]); and further teaches a no-switching criterion includes a value being greater than a threshold (the image capture device 10 includes two lenses/groups, of which one is a wide angle lens 20 and one is a normal lens 25, para. 17; the wide angle lens group 20 is initially placed on the optical axis A; the processor 40 controls the capture and processing of images; the processor 40 controls the digital zoom operation when the user activates the external zoom switch 60; at a predetermined point in the digital zoom process, the processor 40 causes a switching element 50 to switch the normal lens 25 into optical axis A and restarts the digital zoom, para. 18; [switching operations happens at predetermined threshold]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the no-switching criterion of Bittner in the zoom digital camera of Corephotonics. The motivation would have been to allow some moderate digital zooming which will not unacceptably deteriorate the image quality of an image capture system using a wide angle lens and a normal lens (Bittner, para. 16). Modified Corephotonics lacks the explicit teaching of a disparity range calculated by global registration, the disparity range being greater than a second threshold. Choe is in the field of accessing multiple different images of an object taken by one or more cameras (abstract) and teaches a disparity range calculated by global registration (a first bundle adjustment can determine initial camera positions in metric space; for input to a second bundle adjustment, the technique can select two images and can generate a dense disparity map between the pair; some implementations can compute the epipolar geometry between these two images using a plane + parallax approach, and can use mutual information for a matching criteria; some implementations can select a pair of images with the lowest 2-D registration error, col. 5, lines 23-35). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the disparity range of Choe in the camera of Corephotonics. The motivation would have been to allow the use of desired calculations, especially which take into account associated errors (Choe, col. 5, lines 23-35). Modified Corephotonics lacks the explicit teaching that the disparity range is greater than a second threshold. However, it would have been obvious to one of ordinary skill in the art at the time of the invention to use a disparity range greater than a second threshold for the no-switching criterion, since, since, where the prior art has shown computations that use settings dependent upon information from the field of view, discovering the optimum or workable ranges involves only routine skill in the art. The motivation would have been to allow a desired amount or level of accuracy, smoothness, scale, or resolution, as was known in the optical or camera arts.

Claims 1-21 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

ASSIGNMENT

For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the undersigned:

NOY COHEN ODED GIGUSHINSKI NADAV GEVA

GAL SHABTAY ESTER ASHKENAZI RUTHY KATZ

EPHRAIM GOLDENBERG

(hereinafter called the "assignor(s)"), hereby sell(s), assign(s) and transfer(s) to:

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(hereinafter called the "assignee(s)"), its/his successors, assignees, nominees or other legal representatives, the Assignor's entire right, title and interest in and to the invention entitled:

DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

described and claimed in the following National Phase Application No. 15/324,720 identified as Attorney docket No. COREPH-0159 US NP filed 01-08-2017;
and in and to said Patent Applications, and all original and reissued Patents granted therefor, and all divisions and continuations thereof, including the right to apply and obtain Patents in all other countries, the priority rights under International Conventions, and the Letters Patent which may be granted thereon;

Signed and sealed this 8 day of January, 2017

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RUTHY KATZ ______/ Ruthy Katz _/_____

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Application Number:	15324720
International Application Number:	
Confirmation Number:	5811
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	POA.pdf	80500 3a825d40a27dace9f10bf6cdc41658fe55936f70	no	2

Warnings:

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June 27, 2016

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APPLICATION NUMBER: ***62/204,667***
FILING DATE: ***August 13, 2015***

THE COUNTRY CODE AND NUMBER OF YOUR PRIORITY APPLICATION, TO BE USED FOR FILING ABROAD UNDER THE PARIS CONVENTION, IS ***US62/204,667***

Certified by

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I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 92342

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

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SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature	/GAL SHABTAY/	Date	2015-08-13
Name	GAL SHABTAY	Telephone	
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DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

FIELD

Embodiments disclosed herein relate in general to digital cameras and in particular to zoom digital cameras with video capabilities

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size. Further, there is an increasing demand for such cameras to have higher-performance characteristics. One such characteristic possessed by many higher-performance cameras (e.g., standalone digital still cameras) is the ability to vary the focal length of the camera to increase and decrease the magnification of the image. This ability, typically accomplished with a zoom lens, is known as optical zooming. "Zoom" is commonly understood as a capability to provide different magnifications of the same scene and/or object by changing the focal length of an optical system, with a higher level of zoom associated with greater magnification and a lower level of zoom associated with lower magnification. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other. Such zoom lenses are typically more expensive, larger and less reliable than fixed focal length lenses. An alternative approach for approximating the zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a magnified but lower-resolution image.

Attempts to use multi-aperture imaging systems to approximate the effect of a zoom lens are known. A multi-aperture imaging system (implemented for example in a digital camera) includes a plurality of optical sub-systems (also referred to as "sub-cameras"). Each sub-camera includes one or more lenses and/or other optical elements which define an aperture such that received electro-magnetic radiation is imaged by the optical sub-system and a resulting image is directed towards a two-dimensional (2D) pixelated image sensor region. The image sensor (or simply "sensor") region is configured to receive the image and to generate a set of image data based on the image. The digital camera may be aligned to receive electromagnetic radiation associated with scenery having a given set of one or more objects. The set of image data may be represented as digital image data, as well known in the art. Hereinafter in this description, "image" "image data" and "digital image data" may be used interchangeably. Also, "object" and "scene" may be used interchangeably. As used herein, the term "object" is an entity in the real world imaged to a point or pixel in the image.

Multi-aperture imaging systems and associated methods are described for example in US Patent Publications No. 2008/0030592, 2010/0277619 and 2011/0064327. In US 2008/0030592, two sensors are operated simultaneously to capture an image imaged through an associated lens. A sensor and its associated lens form a lens/sensor combination. The two lenses have different focal lengths. Thus, even though each lens/sensor combination is aligned to look in the same direction, each captures an image of the same subject but with two different fields of view (FOVs). One sensor is commonly called "Wide" and the other "Tele". Each sensor provides a separate image, referred to respectively as "Wide" (or "W") and "Tele" (or "T") images. A W-image reflects a wider FOV and has lower resolution than the T-image. The images are then stitched (fused) together to form a composite ("fused") image. In the composite image, the central portion is formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length, and the peripheral portion is formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values from the chosen amount of zoom to provide a respective zoom image. The solution offered by US 2008/0030592 requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).

US 2010/0277619 teaches a camera with two lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a FOV approximately 2-3 times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image is provided from the lens/sensor combination having a FOV that is next larger than the requested FOV. Thus, if the requested FOV is less than the smaller FOV combination, the zoomed image is created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested FOV is greater than the smaller FOV combination, the zoomed image is created from the image captured by the other combination, using cropping and interpolation if necessary. The solution offered by US 2010/0277619 leads to parallax artifacts when moving to the Tele camera in video mode.

In both US 2008/0030592 and US 2010/0277619, different focal length systems cause Tele and Wide matching FOVs to be exposed at different times using CMOS sensors. This degrades the overall image quality. Different optical F numbers ("F#") cause image intensity differences. Working with such a dual sensor system requires double bandwidth support, i.e. additional wires from the sensors to the following HW component. Neither US 2008/0030592 nor US 2010/0277619 deal with registration errors.

US 2011/0064327 discloses multi-aperture imaging systems and methods for image data fusion that include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes overlap at least partially in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data sub-cameras such that each of the sub-cameras is based on at least one characteristic of the second collection, and each sub-camera spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data sub-cameras. The systems and methods disclosed in this application deal solely with fused still images.

None of the known art references provide a thin (e.g. fitting in a cell-phone) dual-aperture zoom digital camera with fixed focal length lenses, the camera configured to operate in both still mode and video mode to provide still and video images, wherein the camera configuration does not use any fusion to provide a continuous, smooth zoom in video mode.

Therefore there is a need for, and it would be advantageous to have thin digital cameras with optical zoom operating in both video and still mode that do not suffer from commonly encountered problems and disadvantages, some of which are listed above.

SUMMARY

Embodiments disclosed herein teach the use of dual-aperture (also referred to as dual-lens or two-sensor) optical zoom digital cameras. The cameras include two sub-cameras, a Wide sub-camera and a Tele sub-camera, each sub-camera including a fixed focal length lens, an image sensor and an image signal processor (ISP). The Tele sub-camera is the higher zoom sub-camera and the Wide sub-camera is the lower zoom sub-camera. In some embodiments, the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1. The image sensor may include two separate 2D pixelated sensors or a single pixelated sensor divided into at least two areas. The digital camera can be operated in both still and video modes. In video mode, optical zoom is achieved "without fusion", by, in some embodiments, switching between the W and T images to shorten computational time requirements, thus enabling high video rate. To avoid discontinuities in video mode, the switching includes applying additional processing blocks, which include in some embodiments image scaling and shifting. In some embodiments, when a no-switching criterion is fulfilled, optical zoom is achieved in video mode without switching.

As used herein, the term "video" refers to any camera output that captures motion by a series of pictures (images), as opposed to "still mode" that friezes motion. Examples of "video" in cellphones and smartphones include "video mode" or "preview mode".

In order to reach optical zoom capabilities, a different magnification image of the same scene is captured (grabbed) by each camera sub-camera, resulting in FOV overlap between the two sub-cameras. Processing is applied on the two images to fuse and output one fused image in still mode. The fused image is processed according to a user zoom factor request. As part of the fusion procedure, up-sampling may be applied on one or both of the grabbed images to scale it to the image grabbed by the Tele sub-camera or to a scale defined by the user. The fusion or up-sampling may be applied to only some of the pixels of a sensor. Down-sampling can be performed as well if the output resolution is smaller than the sensor resolution.

The cameras and associated methods disclosed herein address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras. They provide an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW).

In a dual-aperture camera image plane, as seen by each sub-camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either sub-camera image or the shape or position of a combination thereof. If the output image retains the Wide image shape then it has the Wide perspective POV. If it retains the Wide camera position then it has the Wide position POV. The same applies for Tele images position and perspective. As used in this description, the perspective POV may be of the Wide or Tele sub-cameras, while the position POV may shift continuously between the Wide and Tele sub-cameras. In fused images, it is possible to register Tele image pixels to a matching pixel set within the Wide image pixels, in which case the output image will retain the Wide POV ("Wide fusion"). Alternatively, it is possible to register Wide image pixels to a matching pixel set within the Tele image pixels, in which case the output image will retain the Tele POV ("Tele fusion"). It is also possible to perform the registration after either sub-camera image is shifted, in which case the output image will retain the respective Wide or Tele perspective POV.

In an embodiment, there is provided a zoom digital camera comprising a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene, a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene, and a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

In an embodiment there is provided a method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of providing in the digital camera a Wide imaging section having a Wide lens with a Wide FOV and a Wide sensor, a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections, and configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF value and a higher ZF value.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting examples of embodiments disclosed herein are described below with reference to figures attached hereto that are listed following this paragraph. Identical structures, elements or parts that appear in more than one figure are generally labeled with a same numeral in all the figures in which they appear. The drawings and descriptions are meant to illuminate and clarify embodiments disclosed herein, and should not be considered limiting in any way.

FIG. 1A shows exemplary feature points in an object;

FIG. 1B shows schematically a block diagram illustrating a dual-aperture zoom imaging system disclosed herein;

FIG. 1C is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A:

FIG. 2 shows an example of Wide sensor, Tele sensor and their respective FOVs;

FIG. 3 shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode;

FIG. 4 shows a graph illustrating an effective resolution zoom factor.

DETAILED DESCRIPTION

Definitions:

Sharpness score: the gradients (dx, dy) of the image are compared (subtraction) to the gradients of its low pass filtered version. A higher difference indicates a sharper original image. The result of this comparison is normalized with respect to the average variations (for example, sum of absolute gradients) of the original image, to get an absolute sharpness score.

Edge score: for each image, the edges are found (for example, using Canny edge detection) and the average intensity of gradients along them is calculated, for example, by calculating the magnitude of gradients (dx, dy) for each edge pixel, summing the results together and dividing by the total number of edge pixels. The result is the edge score.

Resolution metric: is calculated only on a region of interest (ROI) and gives a good indication of the effective resolution level in the image. As used herein, "ROI" is a user defined sub-region of the image that may be exemplarily 4% or less of the image area. The effective resolution score can be derived from a combination of the sharpness and edge scores for each image, for example by normalizing both to be between [0, 1] and by taking their average.

FIG. 1C shows schematically a block diagram illustrating an embodiment of a dual-aperture zoom imaging system (also referred to simply as "digital camera" or "camera") disclosed herein and numbered **100**. Camera **100** comprises a Wide imaging section ("sub-camera") that includes a Wide lens block **102,** a Wide image sensor **104** and a Wide image processor **106.** Camera **100** further comprises a Tele imaging section ("sub-camera") that includes a Tele lens block **108,** a Tele image sensor **110** and a Tele image processor **112**. The image sensors may be physically separate or may be part of a single larger image sensor. The Wide sensor pixel size can be equal to or different from the Tele sensor pixel size. Camera **100** further comprises a camera fusion processing core (also referred to as "controller") **114** that includes a sensor control module **116**, a user control module **118,** a video processing module **126** and a capture processing module **128,** all operationally coupled to sensor control block **110**. User control module **118** comprises an operational mode function **120**, a ROI function **122** and a zoom factor (ZF) function **124**.

Sensor control module **116** is connected to the two sub-cameras and to the user control module **118** and used to choose, according to the zoom factor, which of the sensors is operational and to control the exposure mechanism and the sensor readout. Mode choice function **120** is used for choosing capture/video modes. ROI function **122** is used to choose a region of interest. The ROI is the region on which both sub-cameras are focused on. Zoom factor function **124** is used to choose a zoom factor. Video processing module **126** is connected to mode choice function **120** and used for video processing. It is configurable to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data and to make a decision regarding video output. Specifically, upon evaluation of a no-switching criterion, if the no-switching criterion is fulfilled, module **126** is configurable to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value. If the no-switching criterion is not fulfilled, module **126** is configurable to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view. Still processing module **128** is connected to the mode choice function **120** and used for high image quality still mode images. The video processing module is applied when the user desires to shoot in video mode. The capture processing module is applied when the user wishes to shoot still pictures.

FIG. 1D is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1C. Exemplary dimensions: Wide lens TTL = 4.2mm and EFL = 3.5mm; Tele lens TTL = 6mm and EFL = 7 mm; both Wide and Tele sensors 1/3 inch. External dimensions of Wide and Tele cameras: width (w) and length (l) = 8.5 mm and height (h) = 6.8 mm. Distance "d" between camera centers = 10mm.

Following is a detailed description and examples of different methods of use of camera **100.**

Still mode operation/function

In still camera mode, the obtained image is fused from information obtained by both sub-cameras at all zoom levels, see FIG. 2, which shows a Wide sensor **202** and a Tele sensor **204** and their respective FOVs. Exemplarily, as shown, the Tele sensor FOV is half the Wide sensor FOV. The still camera mode processing includes two stages: (1) setting HW settings and configuration, where a first objective is to control the sensors in such a way that matching FOVs in both images (Tele and Wide) are scanned at the same time. A second objective is to control the relative exposures according to the lens properties. A third objective is to minimize the required bandwidth from both sensors for the ISPs; and (2) image processing that fuses the Wide and the Tele images to achieve optical zoom, improves SNR and provides wide dynamic range.

FIG. 3 shows image line numbers vs. time for an image section captured by CMOS sensors. A fused image is obtained by line (row) scans of each image. To prevent matching FOVs in both sensors to be scanned at different times, a particular configuration is applied by the camera controller on both image sensors while keeping the same frame rate. The difference in FOV between the sensors determines the relationship between the rolling shutter time and the vertical blanking time for each sensor.

Video mode operation/function

Smooth transition

When a dual-aperture camera switches the camera output between sub-cameras or points of view, a user will normally see a "jump" (discontinuous) image change. However, a change in the zoom factor for the same camera and POV is viewed as a continuous change. A "smooth transition" (ST) is a transition between cameras or POVs that minimizes the jump effect. This may include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the sub-camera outputs is in many cases impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in a smooth transition as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

Zoom-in and Zoom-out in video mode

In video mode, sensor oversampling is used to enable continuous and smooth zoom experience. Processing is applied to eliminate the changes in the image during crossover from one sub-camera to the other. Zoom from 1 to Z_{switch} is performed using the Wide sensor only. From Z_{switch} and on, it is performed mainly by the Tele sensor. To prevent "jumps" (roughness in the image), switching to the Tele image is done using a zoom factor which is a bit higher (Z_{switch} +ΔZoom) than Z_{switch}. ΔZoom is determined according to the system's properties and is different for cases where zoom-in is applied and cases where zoom-out is applied ($\Delta Zoom_{in} \neq \Delta Zoom_{out}$). This is done to prevent residual jumps artifacts to be visible at a certain zoom factor. The switching between sensors, for an increasing zoom and for decreasing zoom, is done on a different zoom factor.

The zoom video mode operation includes two stages: (1) sensor control and configuration, and (2) image processing. In the range from 1 to Z_{switch}, only the Wide sensor is operational, hence, power can be supplied only to this sensor. Similar conditions hold for a Wide AF mechanism. From Z_{switch}+ΔZoom to Z_{max} only the Tele sensor is operational, hence, power is supplied only to this sensor. Similarly, only the Tele sensor is operational and power is supplied only to it for a Tele AF mechanism. Another option is that the Tele sensor is operational and the Wide sensor is working in low frame rate. From Z_{switch} to Z_{switch}+ΔZoom, both sensors are operational.

Zoom-in: at low ZF up to slightly above ZF_T (the zoom factor that enables switching between Wide and Tele outputs) the output image is the digitally zoomed, unchanged Wide camera output. ZF_T is defined as follows:

$$ZF_T = \mathrm{Tan}\,(FOV_{Wide})/\mathrm{Tan}\,(FOV_{Tele})$$

where Tan refers to "tangent", while FOV_{Wide} and FOV_{Tele} refer respectively to the Wide and Tele lens fields of view (in degrees). As used herein, the FOV is measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition). Switching cannot take place below ZF_T and it can above it.

In some embodiments for the up-transfer ZF, as disclosed in co-invented and co-owned US patent application 14,365711, the output is a transformed Tele sub-camera output, where the transformation is performed by a global registration (GR) algorithm to achieve smooth transition. As used herein "global registration" refers to an action for which the inputs are the Wide and Tele images. The Wide image is cropped to display the same FOV as the

Tele image. The Tele image is passed through a low pass filter (LPF) and resized to make its appearance as close as possible to the Wide image (lower resolution and same pixel count). The outputs of GR are corresponding feature point pairs in the images along with their disparities, and parameters for differences between the images, i.e. shift and scale. As used herein, "feature point" refers to a point such as see points **10a-d** in FIG. 1A and refers to a point (pixel) of interest on an object in an image. For purposes set forth in this description, a feature point should be reproducible and invariant to changes in image scale, noise and illumination. Such points usually lie on corners or other high-contrast regions of the object.

Stages of GR

In some exemplary embodiments, global registration may be performed as follows:

1. Find interest points (features) in each image separately by filtering it with, exemplarily, a Difference of Gaussians filter and finding local extrema on the resulting image.

2. Find feature correspondences (features in both images that describe the same point in space) in a "matching" process. These are also referred to as "feature pairs", "correspondence pairs" or "matching pairs". This is done by comparing each feature point from one (Tele or Wide) image (referred to hereinafter as "image 1") to all feature points in that region from the other (respectively Wide or Tele) image (referred to hereinafter as "image 2"). The features are compared only within their group of minima/maxima, using patch normalized cross-correlation. As used herein, "patch" refers to a group of neighboring pixels around an origin pixel.

3. The normalized cross correlation of two image patches $t(x,y)$ and $f(x,y)$ is $\frac{1}{n}\sum_{x,y}\frac{(f(x,y)-\bar{f})(t(x,y)-\bar{t})}{\sigma_f \sigma_t}$ where n is the number of pixels in both patches, $\bar{f}$ is the average of f and σ_f is the standard deviation of f. A match for a feature point from image 1 is only confirmed if its correlation score is much higher (for example, x1.2) than the next-best matching feature from image 2.

4. Find the disparity between each pair of corresponding features (also referred to as "matching pair") by subtracting their x and y coordinate values.

5. Filter bad matching points:

a. Following the matching process, matches that include feature points from image 2 that were matched to more than one feature from image 1 are discarded.

b. Matching pairs whose disparity is inconsistent with the other matching pairs are discarded. For example, if there is one corresponding pair which whose disparity is lower or higher than the others by 20 pixels.

6. The localization accuracy for matched points from image 2 is refined by calculating a correlation of neighboring pixel patches from image 2 with the target patch (the patch around the current pixel (of the current matching pair) from image 1, modeling the results as a parabola and finding its maximum.

7. Rotation and fine scale differences are calculated between the two images according to the matching points (for example, by subtracting the center of mass from each set of points, i.e. the part of the matching points belonging to either the Wide or the Tele image, and solving a least squares problem).

8. After compensating for these differences, since the images were rectified, the disparity in the Y axis should be close to 0. Matching points that do not fit this criterion are discarded.

9. Finally, the remaining matching points are considered true and the disparities for them are calculated. A weighted average of the disparity is taken as the shift between both images. The maximum difference between disparity values is taken as the disparity range.

10. At various stages during GR, if there are not enough feature/matching points remaining, the GR is stopped and returns a failure flag.

In addition, it is possible to find range calibration to the rectification process by finding the shiftI = shift for objects at infinity and defining shiftD=shift-shiftI and disparity D = disparity-shiftI. We then calculate $object\ distance = \frac{focalLength \cdot baseline}{disparityD \cdot pixelSize}$, where "baseline" is the distance between cameras.

Returning now to the Zoom-in process, in some embodiments, for higher ZF than the up-transfer ZF the output is the transformed Tele sub-camera output, digitally zoomed. However, in other embodiments for the up-transfer ZF there will be no switching from the Wide to the Tele sub-camera output, i.e. the output will be from the Wide sub-camera, digitally zoomed. This "no switching" process is described next.

No Switching

Switching from the Wide sub-camera output to the transformed Tele sub-camera output will be performed unless some special condition (criterion), determined based on inputs obtained from the two sub-camera images, occurs. In other words, switching will not be performed only if at least one of the following no-switching criteria is fulfilled:

1. if the shift calculated by GR is greater than a first threshold, for example 50 pixels.

2. if the disparity range calculated by GR is greater than a second threshold, for example 20 pixels, because in this case there is no global shift correction that will suppress movement/jump for all objects distances (smooth transition is impossible for all objects).

3. if the effective resolution (a result of the resolution metric) of the Tele image is lower than that of the Wide image. In this case, there is no point in performing the transition because no value (i.e. resolution) is gained. Smooth transition is possible but undesirable.

4. if the GR fails, i.e. if the number of matching pairs found is less than a third threshold, for example 20 matching pairs.

5. if, for example, that are imaged onto the overlap area are calculated to be closer than a first threshold distance, for example 30 cm, because this can result in a large image shift to obtain ST.

6. if some objects (for example two objects) that are imaged in the overlap area are calculated to be closer than a second threshold distance, for example 50 cm, while other objects (for example two objects) are calculated to be farther than a third distance threshold, for example 10 m. The reason is that the shift between an object position in the Wide and Tele sub-cameras is object distance dependent, where the closer the objects the larger the shift, so an image containing significantly close and far objects cannot be matched by simple transformation (shift scale) to be similar and thus provide ST between cameras.

Zoom-out: at high ZF down to slightly below Z_{FT}, the output image is the digitally zoomed transformed Tele camera output. For the down-transfer ZF, the output is a shifted Wide camera output, where the Wide shift correction is performed by the GR algorithm to achieve smooth transition, i.e. with no jump in the ROI region. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

Note that if a no-switching criterion is not fulfilled, then the camera will output without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, the video output images being provided with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

FIG. 3 shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode for 3 different zoom factor (ZF) ranges: (a) ZF range = 1 :

Z_{switch}; (b) ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$: and (c) Zoom factor range = Z_{switch} + $\Delta Zoom_{in}$: Z_{max}. The description is with reference to a graph of effective resolution vs. zoom value (FIG. 7). In step **302**, sensor control module **116** chooses (directs) the sensor (Wide, Tele or both) to be operational. Specifically, if the ZF range = 1:Z_{switch}, module **116** directs the Wide sensor to be operational and the Tele sensor to be non-operational. If the ZF range is Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, module **116** directs both sensors to be operational and the zoom image is generated from the Wide sensor. If the ZF range is Z_{switch} + $\Delta Zoom_{in}$: Z_{max}, module **116** directs the Wide sensor to be non-operational and the Tele sensor to be operational. After the sensor choice in step **302,** all following actions are performed in video processing core **126**. Optionally, in step **304,** color balance is calculated if two images are provided by the two sensors. Optionally yet, in step **306**, the calculated color balance is applied in one of the images (depending on the zoom factor). Further optionally, in step **308**, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient can be used to set an AF position in step **310**. In step **312**, an output of any of steps **302-308** is applied on one of the images (depending on the zoom factor) for image signal processing that may include denoising, demosaicing, sharpening, scaling, etc. In step **314**, the processed image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p). To avoid a transition point to be executed at the same ZF, $\Delta Zoom$ can change while zooming in and while zooming out. This will result in hysteresis in the sensor switching point.

In more detail, for ZF range 1: Z_{switch}, for ZF < Z_{switch}, the Wide image data is transferred to the ISP in step **312** and resampled in step **314**. For ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, both sensors are operational and the zoom image is generated from the Wide sensor. The color balance is calculated for both images according to a given ROI. In addition, for a given ROI, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient is used to set an AF position. The transformation coefficient includes the translation between matching points in the two images. This translation can be measured in a number of pixels. Different translations will result in a different number of pixel movements between matching points in the images. This movement can be translated into depth and the depth can be translated into an AF position. This enables to set the AF position by only analyzing two images (Wide & Tele). The result is fast focusing.

Both color balance ratios and transformation coefficient are used in the ISP step. In parallel, the Wide image is processed to provide a processed image, followed by resampling.

For ZF range = $Z_{switch} + \Delta Zoom_{in} : Z_{max}$ and for Zoom factor > $Z_{switch,} + \Delta Zoom_{in}$, the color balance calculated previously is now applied on the Tele image. The Tele image data is transferred to the ISP in step **312** and resampled in step **314**. To eliminate crossover artifacts and to enable smooth transition to the Tele image, the processed Tele image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p).

FIG. 4 shows the effective resolution as a function of the zoom factor for a zoom-in case and for a zoom-out case $\Delta Zoom_{up}$ is set when we zoom in, and $\Delta Zoom_{down}$ is set when we zoom out. Setting $\Delta Zoom_{up}$ to be different from $\Delta Zoom_{down}$ will result in transition between the sensors to be performed at different zoom factor ("hysteresis") when zoom-in is used and when zoom-out is used. This hysteresis phenomenon in the video mode results in smooth continuous zoom experience.

In conclusion, dual aperture optical zoom digital cameras and associate methods disclosed herein reduce the amount of processing resources, lower frame rate requirements, reduce power consumption, remove parallax artifacts and provide continuous focus (or provide loss of focus) when changing from Wide to Tele in video mode. They provide a dramatic reduction of the disparity range and avoid false registration in capture mode. They reduce image intensity differences and enable work with a single sensor bandwidth instead of two, as in known cameras.

All patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present disclosure.

While this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of the embodiments and methods will be apparent to those skilled in the art. The disclosure is to be understood as not limited by the specific embodiments described herein, but only by the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

2. The camera of claim 1, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

3. The camera of claim 1, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

4. The camera of claim 1, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

5. The camera of claim 1, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

6. The camera of claim 1, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

7. The camera of claim 1, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

8. The camera of claim 1, wherein the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

9. The camera of claim 8, wherein the user inputs include a zoom factor, a camera mode and a region of interest.

10. The camera of claim 1, wherein the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1.

11. The camera of claim 1, wherein, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

12. The camera of claim 1, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

13. A method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV) and a Wide sensor, a Tele imaging section having a Tele lens with

a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

14. The method of claim 13, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

15. The method of claim 13, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

16. The method of claim 13, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

17. The method of claim 13, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

18. The method of claim 13, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

19. The method of claim 13, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

20. The method of claim 13, further comprising the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the

Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

21. The method of claim 13, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

ABSTRACT

A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operatively coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The controller is configured to output, in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value, a zoom video output image that includes only Wide image data or only Tele image data, depending on whether a no-switching criterion is fulfilled or not.

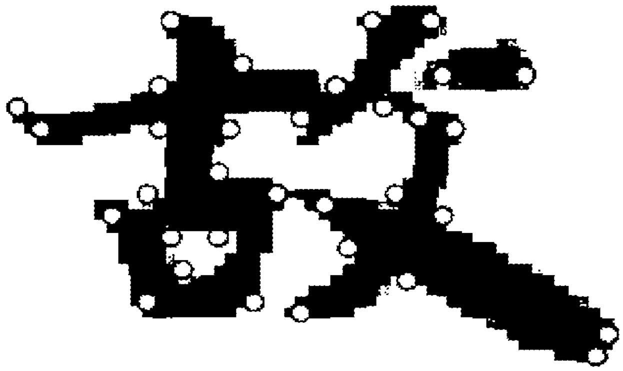

FIG. 1A

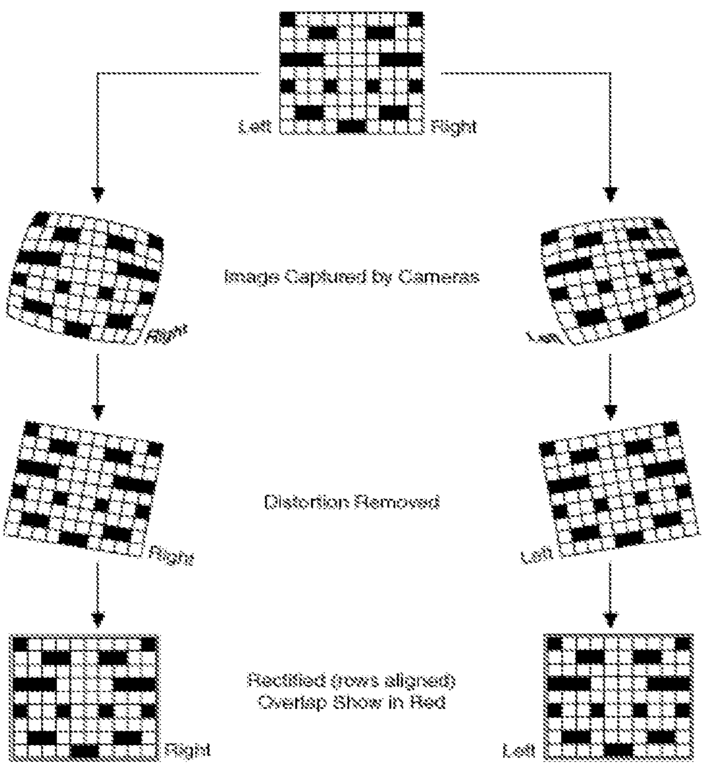
Left
Right
Image Captured by Cameras
Right
Left
Distortion Removed
Right
Left
Rectified (rows aligned)
Overlap Show in Red
Right
Left

FIG. 1B

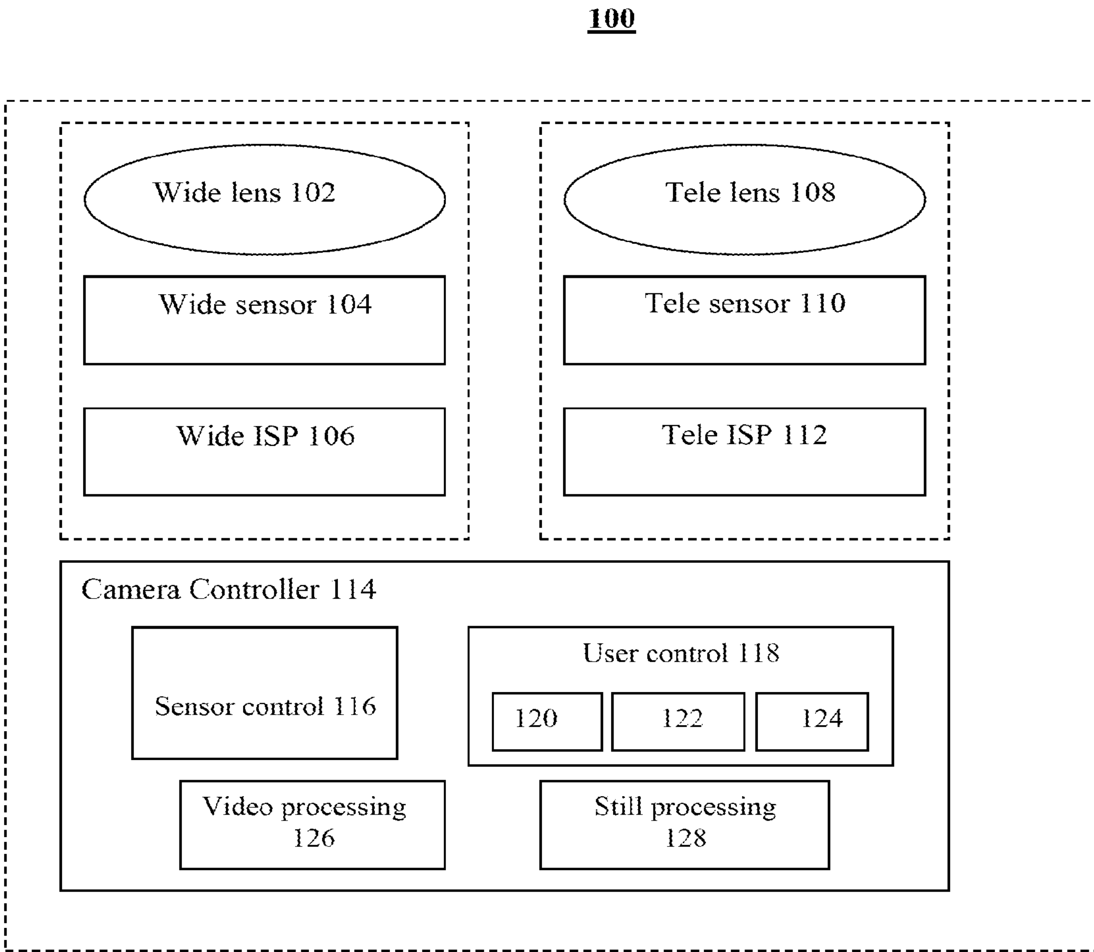
100
Wide lens 102
Wide sensor 104
Wide ISP 106
Tele lens 108
Tele sensor 110
Tele ISP 112
Camera Controller 114
Sensor control 116
User control 118
120
122
124
Video processing 126
Still processing 128

FIG. 1C

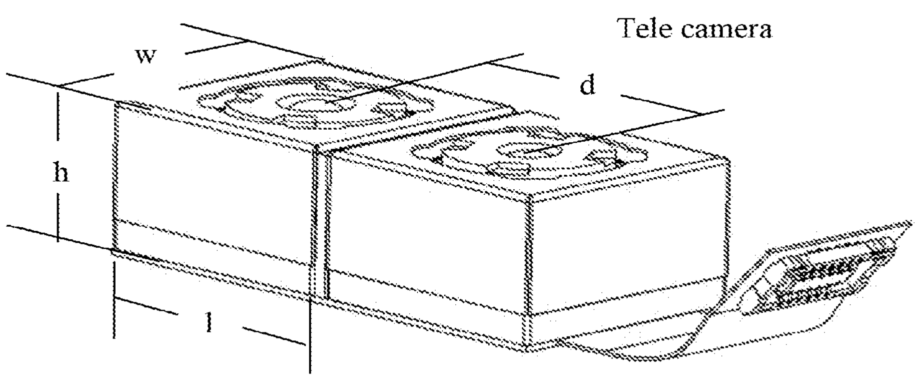
Tele camera
w
d
h
l

FIG. 1D

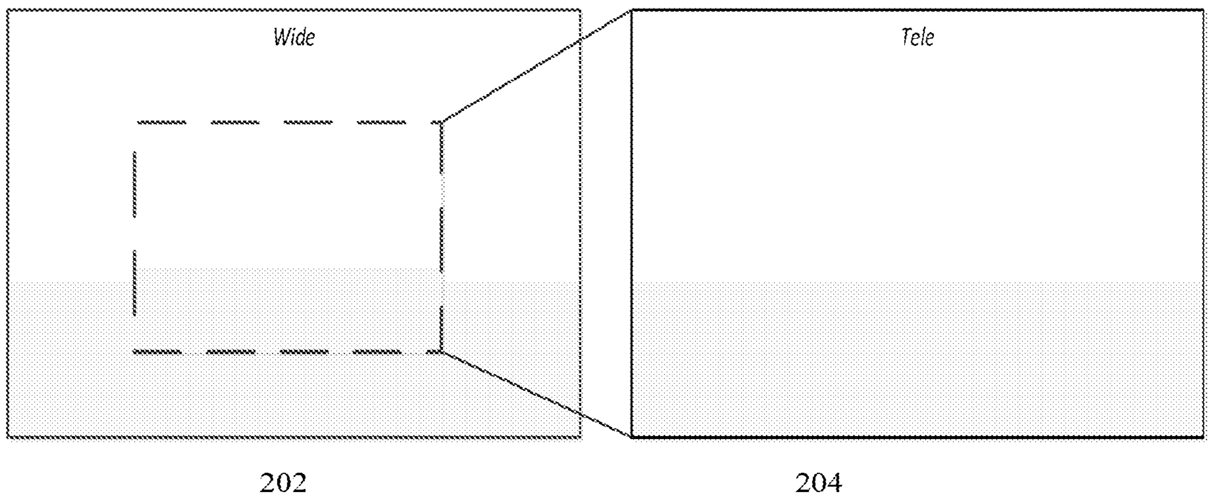

FIG. 2

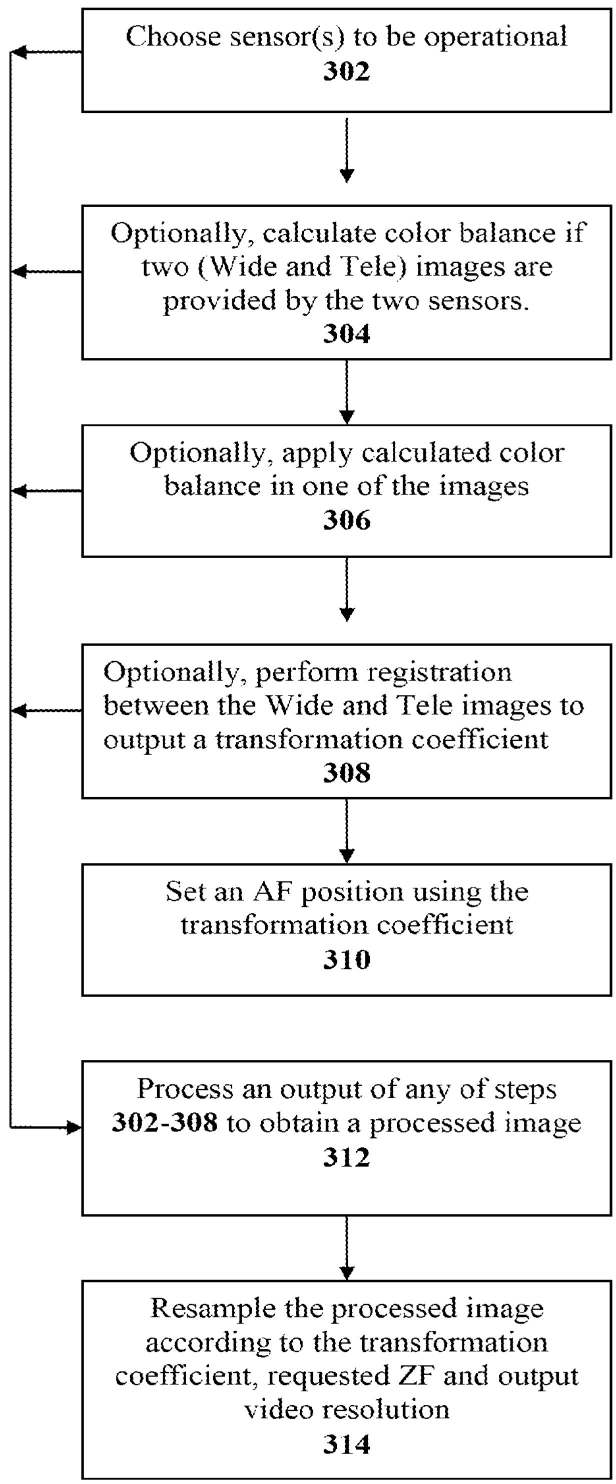
Choose sensor(s) to be operational
302
Optionally, calculate color balance if two (Wide and Tele) images are provided by the two sensors.
304
Optionally, apply calculated color balance in one of the images
306
Optionally, perform registration between the Wide and Tele images to output a transformation coefficient
308
Set an AF position using the transformation coefficient
310
Process an output of any of steps 302-308 to obtain a processed image
312
Resample the processed image according to the transformation coefficient, requested ZF and output video resolution
314

FIG. 3

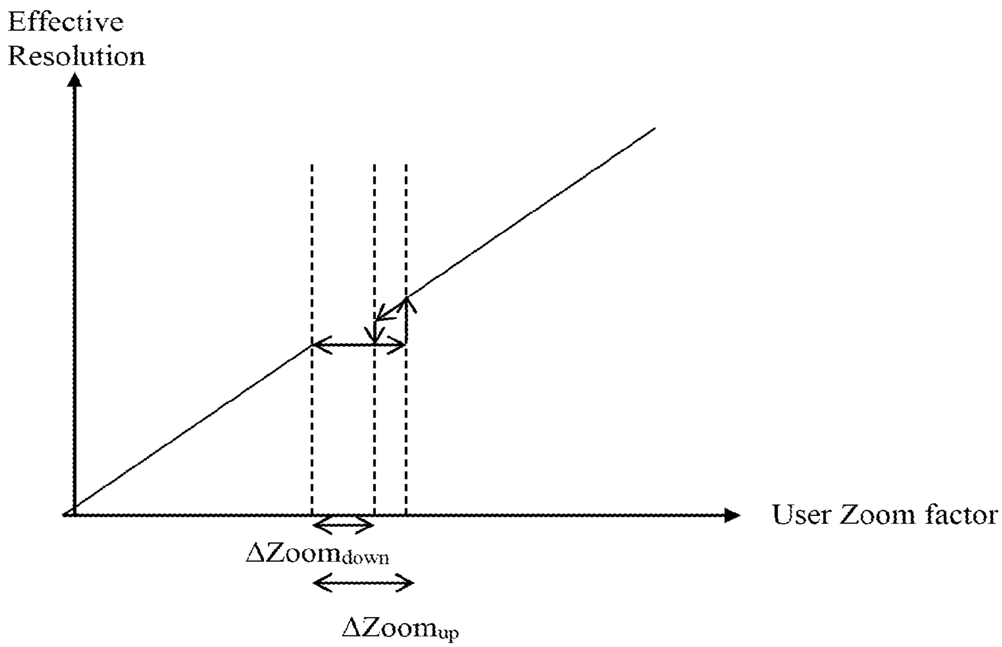

FIG. 4

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

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Legal Name

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Prefix	Given Name	Middle Name	Family Name	Suffix
	Nadav		Geva	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Tel-Aviv	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	3 Vormaiza St.		
Address 2			
City	Tel-Aviv	State/Province	
Postal Code	6264203	Country i	IL

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Gal		Shabtay	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Tel-Aviv	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	4 Shmuel Shnitzer St.		
Address 2			
City	Tel-Aviv	State/Province	
Postal Code	6958313	Country i	IL

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ester		Ashkenazi	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Modi'in	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	52/2 Emeq Dotan St.		
Address 2			
City	Modi'in	State/Province	
Postal Code	7170202	Country i	IL

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Inventor 6 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Ruthy		Katz	

Residence Information (Select One) ◯ US Residency ◉ Non US Residency ◯ Active US Military Service

City	Tel Aviv	Country of Residence i	IL

Mailing Address of Inventor:

Address 1	6/20 Hachmey Kiruan St.		
Address 2			
City	Tel Aviv	**State/Province**	
Postal Code	6423706	**Country** i	IL

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	92342	
Email Address		Add Email Remove Email

Application Information:

Title of the Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL		
Attorney Docket Number	COREPH-0159 US PR	**Small Entity Status Claimed**	☒
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)		**Suggested Figure for Publication (if any)**	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	92342		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(d). When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) i the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(h)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country i	Filing Date (YYYY-MM-DD)	Access Code i (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If checked, the undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

◉ Assignee ◯ Legal Representative under 35 U.S.C. 117 ◯ Joint Inventor

◯ Person to whom the inventor is obligated to assign. ◯ Person who shows sufficient proprietary interest

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor :	
If the Applicant is an Organization check here.	☒
Organization Name	Corephotonics Ltd.

Mailing Address Information:

Address 1	25 Habarzel St.		
Address 2	Ramat Hachayal		
City	Tel-Aviv	**State/Province**	
Country i	IL	Postal Code	6971035
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Non-Applicant Assignee Information:

Providing assignment information in this section does not subsitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1

Complete this section only if non-applicant assignee information is desired to be included on the patent application publication in accordance with 37 CFR 1.215(b). Do not include in this section an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest), as the patent application publication will include the name of the applicant(s).

Remove

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	COREPH-0159 US PR
	Application Number	
Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL	

Mailing Address Information:			
Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications

Signature	/Menachem Nathan/			Date (YYYY-MM-DD)	2015-08-13
First Name	MENACHEM	Last Name	NATHAN	Registration Number	65392

Additional Signature may be generated within this form by selecting the Add button. Add

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	23201965
Application Number:	62204667
International Application Number:	
Confirmation Number:	7706
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
Filer:	Menachem Nathan
Filer Authorized By:	
Attorney Docket Number:	COREPH-0159 US PR
Receipt Date:	13-AUG-2015
Filing Date:	
Time Stamp:	15:02:04
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$130
RAM confirmation Number	1223
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Provisional Cover Sheet (SB16)	CoverSheet.pdf	2071884 1cfafbc9d36fc0cf7e08589e2e1dc5466b55d939	no	4
Warnings:					
Information:					
2	Power of Attorney	POA.pdf	80469 2c0ced0095461f0d5e9642197644b090abce6978	no	2
Warnings:					
Information:					
3	Assignee showing of ownership per 37 CFR 3.73	Assignment.pdf	18311 e706970493ca79b12f7ea501c2d605fe6450fff6	no	1
Warnings:					
Information:					
4	Assignee showing of ownership per 37 CFR 3.73	STATEMENT.pdf	117641 48818859135601b45c07b8580f43c4d999b93762	no	3
Warnings:					
Information:					
5	Specification	filing.pdf	8212688 49fbec35a67bb47ebc1c622192df6596e5f5f131	no	25
Warnings:					
Information:					
6	Application Data Sheet	ADS.pdf	1503960 c2b53797bdb33a8b30c22f0c4708e04843dccced	no	8
Warnings:					
Information:					
7	Fee Worksheet (SB06)	fee-info.pdf	29893 687be29cffe618e4a493c2a1e02aa1f0d49d11fe	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	12034846		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Provisional Application for Patent Cover Sheet

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c)

Inventor(s)

Inventor 1 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Noy		Cohen	Tel-Aviv		IL

Inventor 2 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Oded		Gigushinski	Herzlia		IL

Inventor 3 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Nadav		Geva	Tel-Aviv		IL

Inventor 4 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Gal		Shabtay	Tel-Aviv		IL

Inventor 5 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Ester		Ashkenazi	Modi'in		IL

Inventor 6 — Remove

Given Name	Middle Name	Family Name	City	State	Country i
Ruthy		Katz	Tel-Aviv		

All Inventors Must Be Listed – Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Title of Invention	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
Attorney Docket Number (if applicable)	COREPH-0159 US PR

Correspondence Address

Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

Direct all correspondence to (select one):	
(●) The address corresponding to Customer Number	( ) Firm or Individual Name
Customer Number	92342

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.
(●) No.
( ) Yes, the name of the U.S. Government agency and the Government contract number are:

Doc Code: **TR.PROV**
Document Description: Provisional Cover Sheet (SB16)

Entity Status

Applicant claims small entity status under 37 CFR 1.27

◉ Yes, applicant qualifies for small entity status under 37 CFR 1.27

○ No

Warning

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

Signature

Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Menachem Nathan/			Date (YYYY-MM-DD)	2015-05-14
First Name	Menachem	Last Name	Nathan	Registration Number (If appropriate)	65392

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **This form can only be used when in conjunction with EFS-Web. If this form is mailed to the USPTO, it may cause delays in handling the provisional application.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or paten. Accordingly, pursuant to the requirements of the Act, please be advised that : (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, t o a n other federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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DOCUMENT MADE AVAILABLE UNDER THE PATENT COOPERATION TREATY (PCT)

International application number:		**PCT/IB2016/053803**
International filing date:		**26 June 2016 (26.06.2016)**
Document type:		**Certified copy of priority document**
Document details:	Country/Office:	**US**
	Number:	**62/204,667**
	Filing date:	**13 August 2015 (13.08.2015)**
Date of receipt at the International Bureau:		**27 June 2016 (27.06.2016)**

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a),(b) or (b-*bis*)

34, chemin des Colombettes
1211 Geneva 20, Switzerland
www.wipo.int

PCT REQUEST

Print Out (Original in Electronic Form)

0	**For receiving Office use only**	
0-1	International Application No.	PCT/IB2016/053803
0-2	International Filing Date	26 June 2016 (26.06.2016)
0-3	Name of receiving Office and "PCT International Application"	RO/IB

0-4	**Form PCT/RO/101 PCT Request**	
0-4-1	Prepared Using	ePCT-Filing Version 3.3.002 MT/FOP 20151028/0.20.5.24
0-5	**Petition** The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	**Receiving Office (specified by the applicant)**	International Bureau of the World Intellectual Property Organization (RO/IB)
0-7	**Applicant's or agent's file reference**	COREPH-0159
I	**Title of Invention**	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
II	**Applicant**	
II-1	This person is	Applicant only
II-2	Applicant for	All designated States
II-4	Name	COREPHOTONICS LTD.
II-5	Address	25 Habarzel St. Ramat Hachayal 6971035 Tel-Aviv Israel
II-6	State of nationality	IL
II-7	State of residence	IL
II-10	e-mail	info@natpatent.com
II-10(a)	E-mail authorization The receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority are authorized to use this e-mail address, if the Office or Authority so wishes, to send notifications issued in respect of this international application:	exclusively in electronic form (no paper notifications will be sent)

III-1	**Applicant and/or inventor**	
III-1-1	This person is	Inventor only
III-1-3	Inventor for	All designated States
III-1-4	Name (LAST, First)	COHEN, Noy
III-1-5	Address	30 Shlomo Ben Yossef St. 6912529 Tel-Aviv Israel
III-2	**Applicant and/or inventor**	
III-2-1	This person is	Inventor only
III-2-3	Inventor for	All designated States
III-2-4	Name (LAST, First)	GEVA, Nadav
III-2-5	Address	3 Vormaiza St. 6264203 Tel-Aviv Israel
III-3	**Applicant and/or inventor**	
III-3-1	This person is	Inventor only
III-3-3	Inventor for	All designated States
III-3-4	Name (LAST, First)	GIGUSHINSKI, Oded
III-3-5	Address	23 Ahi Dakar St. 4670223 Herzlia Israel
III-4	**Applicant and/or inventor**	
III-4-1	This person is	Inventor only
III-4-3	Inventor for	All designated States
III-4-4	Name (LAST, First)	SHABTAY, Gal
III-4-5	Address	4 Shmuel Shnitzer St. 6958313 Tel-Aviv Israel
III-5	**Applicant and/or inventor**	
III-5-1	This person is	Inventor only
III-5-3	Inventor for	All designated States
III-5-4	Name (LAST, First)	ASHKENAZI, Ester
III-5-5	Address	52/2 Emeq Dotan St. 7170202 Modi'in Israel
III-6	**Applicant and/or inventor**	
III-6-1	This person is	Inventor only
III-6-3	Inventor for	All designated States
III-6-4	Name (LAST, First)	KATZ, Ruthy
III-6-5	Address	6/20 Hachmey Kiruan St. 6423706 Tel Aviv Israel

PCT REQUEST

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III-7	**Applicant and/or inventor**	
III-7-1	This person is	Inventor only
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IV-1	**Agent or common representative; or address for correspondence** The person identified below is hereby/ has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	~~Agent~~ ^ Address for correspondence ^
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V	**DESIGNATIONS**	
V-1	**The filing of this request constitutes under Rule 4.9(a), the designation of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.**	
VI-1	**Priority claim of earlier national application**	
VI-1-1	Filing date	13 August 2015 (13.08.2015)
VI-1-2	Number	62/204,667
VI-1-3	Country or Member of WTO	US
VI-2	**Priority document request** The International Bureau is requested to obtain from a digital library a certified copy of the earlier application(s) identified above as item(s), using, where applicable, the access code(s) indicated:	VI-1 Access code: 7706

^ RO

VI-3	**Incorporation by reference :** where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.		
VII-1	**International Searching Authority Chosen**	United States Patent and Trademark Office (USPTO) (ISA/US)	
VIII	**Declarations**	Number of declarations	
VIII-1	Declaration as to the identity of the inventor	-	
VIII-2	Declaration as to the applicant's entitlement, as at the international filing date, to apply for and be granted a patent	-	
VIII-3	Declaration as to the applicant's entitlement, as at the international filing date, to claim the priority of the earlier application	-	
VIII-4	Declaration of inventorship (only for the purposes of the designation of the United States of America)	-	
VIII-5	Declaration as to non-prejudicial disclosures or exceptions to lack of novelty	-	
IX	**Check list**	Number of sheets	Electronic file(s) attached
IX-1	Request (including declaration sheets)	5	✓
IX-2	Description	16	✓
IX-3	Claims	4	✓
IX-4	Abstract	1	✓
IX-5	Drawings	5	✓
IX-7	TOTAL	31	
	Accompanying Items	Paper document(s) attached	Electronic file(s) attached
IX-8	Fee calculation sheet	-	✓
IX-20	**Figure of the drawings which should accompany the abstract**	3A	
IX-21	**Language of filing of the international application**	English	
IX-22	**The receiving Office is requested to make this international application available to the Priority Document Access Service (DAS) (provided that an international application number and international filing date is accorded to this purported international application.)**	Yes	

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X-1	**Signature of applicant, agent or common representative**	/Gal Shabtay/
X-1-1	Name	COREPHOTONICS LTD.
X-1-2	Name of signatory	Gal Shabtay
X-1-3	Capacity (if such capacity is not obvious from reading the request)	VP R&D

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10-5	**International Searching Authority**	ISA/US
10-6	**Transmittal of search copy delayed until search fee is paid**	

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(54) Title: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

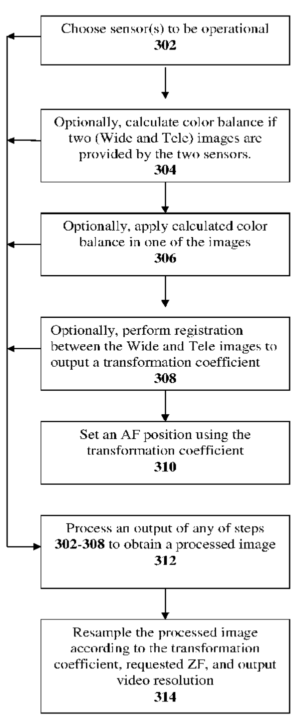

FIG. 3A

(57) Abstract: A dual-aperture zoom digital camera operable in both still and video modes. The camera includes Wide and Tele imaging sections with respective lens/sensor combinations and image signal processors and a camera controller operatively coupled to the Wide and Tele imaging sections. The Wide and Tele imaging sections provide respective image data. The controller is configured to output, in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value, a zoom video output image that includes only Wide image data or only Tele image data, depending on whether a no-switching criterion is fulfilled or not.

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DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims priority from US Provisional Patent Application No. 62/204,667 filed on August 13, 2015 which is expressly incorporated herein by reference in its entirety.

FIELD

Embodiments disclosed herein relate in general to digital cameras and in particular to zoom digital cameras with video capabilities.

BACKGROUND

Digital camera modules are currently being incorporated into a variety of host devices. Such host devices include cellular telephones, personal data assistants (PDAs), computers, and so forth. Consumer demand for digital camera modules in host devices continues to grow.

Host device manufacturers prefer digital camera modules to be small, so that they can be incorporated into the host device without increasing its overall size. Further, there is an increasing demand for such cameras to have higher-performance characteristics. One such characteristic possessed by many higher-performance cameras (e.g., standalone digital still cameras) is the ability to vary the focal length of the camera to increase and decrease the magnification of the image. This ability, typically accomplished with a zoom lens, is known as optical zooming. "Zoom" is commonly understood as a capability to provide different magnifications of the same scene and/or object by changing the focal length of an optical system, with a higher level of zoom associated with greater magnification and a lower level of zoom associated with lower magnification. Optical zooming is typically accomplished by mechanically moving lens elements relative to each other. Such zoom lenses are typically more expensive, larger and less reliable than fixed focal length lenses. An alternative approach for approximating the zoom effect is achieved with what is known as digital zooming. With digital zooming, instead of varying the focal length of the lens, a processor in the camera crops the image and interpolates between the pixels of the captured image to create a magnified but lower-resolution image.

Attempts to use multi-aperture imaging systems to approximate the effect of a zoom lens are known. A multi-aperture imaging system (implemented for example in a digital camera) includes a plurality of optical sub-systems (also referred to as "cameras"). Each camera includes one or more lenses and/or other optical elements which define an aperture such that received electro-magnetic radiation is imaged by the optical sub-system and a resulting image is directed towards a two-dimensional (2D) pixelated image sensor region. The image sensor (or simply "sensor") region is configured to receive the image and to generate a set of image data based on the image. The digital camera may be aligned to receive electromagnetic radiation associated with scenery having a given set of one or more objects. The set of image data may be represented as digital image data, as well known in the art. Hereinafter in this description, "image" "image data" and "digital image data" may be used interchangeably. Also, "object" and "scene" may be used interchangeably. As used herein, the term "object" is an entity in the real world imaged to a point or pixel in the image.

Multi-aperture imaging systems and associated methods are described for example in US Patent Publications No. 2008/0030592, 2010/0277619 and 2011/0064327. In US 2008/0030592, two sensors are operated simultaneously to capture an image imaged through an associated lens. A sensor and its associated lens form a lens/sensor combination. The two lenses have different focal lengths. Thus, even though each lens/sensor combination is aligned to look in the same direction, each combination captures an image of the same subject but with two different fields of view (FOV). One sensor is commonly called "Wide" and the other "Tele". Each sensor provides a separate image, referred to respectively as "Wide" (or "W") and "Tele" (or "T") images. A W-image reflects a wider FOV and has lower resolution than the T-image. The images are then stitched (fused) together to form a composite ("fused") image. In the composite image, the central portion is formed by the relatively higher-resolution image taken by the lens/sensor combination with the longer focal length, and the peripheral portion is formed by a peripheral portion of the relatively lower-resolution image taken by the lens/sensor combination with the shorter focal length. The user selects a desired amount of zoom and the composite image is used to interpolate values from the chosen amount of zoom to provide a respective zoom image. The solution offered by US 2008/0030592 requires, in video mode, very large processing resources in addition to high frame rate requirements and high power consumption (since both cameras are fully operational).

US 2010/0277619 teaches a camera with two lens/sensor combinations, the two lenses having different focal lengths, so that the image from one of the combinations has a FOV approximately 2-3 times greater than the image from the other combination. As a user of the camera requests a given amount of zoom, the zoomed image is provided from the lens/sensor combination having a FOV that is next larger than the requested FOV. Thus, if the requested FOV is less than the smaller FOV combination, the zoomed image is created from the image captured by that combination, using cropping and interpolation if necessary. Similarly, if the requested FOV is greater than the smaller FOV combination, the zoomed image is created from the image captured by the other combination, using cropping and interpolation if necessary. The solution offered by US 2010/0277619 leads to parallax artifacts when moving to the Tele camera in video mode.

In both US 2008/0030592 and US 2010/0277619, different focal length systems cause matching Tele and Wide FOVs to be exposed at different times using CMOS sensors. This degrades the overall image quality. Different optical F numbers ("F#") cause image intensity differences. Working with such a dual sensor system requires double bandwidth support, i.e. additional wires from the sensors to the following HW component. Neither US 2008/0030592 nor US 2010/0277619 deal with registration errors.

US 2011/0064327 discloses multi-aperture imaging systems and methods for image data fusion that include providing first and second sets of image data corresponding to an imaged first and second scene respectively. The scenes overlap at least partially in an overlap region, defining a first collection of overlap image data as part of the first set of image data, and a second collection of overlap image data as part of the second set of image data. The second collection of overlap image data is represented as a plurality of image data cameras such that each of the cameras is based on at least one characteristic of the second collection, and each camera spans the overlap region. A fused set of image data is produced by an image processor, by modifying the first collection of overlap image data based on at least a selected one of, but less than all of, the image data cameras. The systems and methods disclosed in this application deal solely with fused still images.

None of the known art references provide a thin (e.g. fitting in a cell-phone) dual-aperture zoom digital camera with fixed focal length lenses, the camera configured to operate in both still mode and video mode to provide still and video images, wherein the camera configuration does not use any fusion to provide a continuous, smooth zoom in video mode.

Therefore there is a need for, and it would be advantageous to have thin digital cameras with optical zoom operating in both video and still mode that do not suffer from commonly encountered problems and disadvantages, some of which are listed above.

SUMMARY

Embodiments disclosed herein teach the use of dual-aperture (also referred to as dual-lens or two-sensor) optical zoom digital cameras. The cameras include two cameras, a Wide camera and a Tele camera, each camera including a fixed focal length lens, an image sensor and an image signal processor (ISP). The Tele camera is the higher zoom camera and the Wide camera is the lower zoom camera. In some embodiments, the thickness/effective focal length (EFL) ratio of the Tele lens is smaller than about 1. The image sensor may include two separate 2D pixelated sensors or a single pixelated sensor divided into at least two areas. The digital camera can be operated in both still and video modes. In video mode, optical zoom is achieved "without fusion", by, in some embodiments, switching between the W and T images to shorten computational time requirements, thus enabling high video rate. To avoid discontinuities in video mode, the switching includes applying additional processing blocks, which include in some embodiments image scaling and shifting. In some embodiments, when a no-switching criterion is fulfilled, optical zoom is achieved in video mode without switching.

As used herein, the term "video" refers to any camera output that captures motion by a series of pictures (images), as opposed to "still mode" that friezes motion. Examples of "video" in cellphones and smartphones include "video mode" or "preview mode".

In order to reach optical zoom capabilities, a different magnification image of the same scene is captured (grabbed) by each camera, resulting in FOV overlap between the two cameras. Processing is applied on the two images to fuse and output one fused image in still mode. The fused image is processed according to a user zoom factor request. As part of the fusion procedure, up-sampling may be applied on one or both of the grabbed images to scale it to the image grabbed by the Tele camera or to a scale defined by the user. The fusion or up-sampling may be applied to only some of the pixels of a sensor. Down-sampling can be performed as well if the output resolution is smaller than the sensor resolution.

The cameras and associated methods disclosed herein address and correct many of the problems and disadvantages of known dual-aperture optical zoom digital cameras. They provide an overall zoom solution that refers to all aspects: optics, algorithmic processing and system hardware (HW).

In a dual-aperture camera image plane, as seen by each camera (and respective image sensor), a given object will be shifted and have different perspective (shape). This is referred to as point-of-view (POV). The system output image can have the shape and position of either camera image or the shape or position of a combination thereof. If the output image retains the Wide image shape then it has the Wide perspective POV. If it retains the Wide camera position then it has the Wide position POV. The same applies for Tele images position and perspective. As used in this description, the perspective POV may be of the Wide or Tele cameras, while the position POV may shift continuously between the Wide and Tele cameras. In fused images, it is possible to register Tele image pixels to a matching pixel set within the Wide image pixels, in which case the output image will retain the Wide POV ("Wide fusion"). Alternatively, it is possible to register Wide image pixels to a matching pixel set within the Tele image pixels, in which case the output image will retain the Tele POV ("Tele fusion"). It is also possible to perform the registration after either camera image is shifted, in which case the output image will retain the respective Wide or Tele perspective POV.

In an exemplary embodiment, there is provided a zoom digital camera comprising a Wide imaging section that includes a fixed focal length Wide lens with a Wide FOV and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene, a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene, and a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

In an exemplary embodiment there is provided a method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of providing in the digital camera a Wide imaging section having a Wide lens with a Wide FOV and a Wide sensor, a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections, and configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF value and a higher ZF value.

In some exemplary embodiments, the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

In some exemplary embodiments, the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

In some exemplary embodiments, the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

In some exemplary embodiments, the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

In some exemplary embodiments, the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

In some exemplary embodiments, the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

In some exemplary embodiments, the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

In some exemplary embodiments, the user inputs include a zoom factor, a camera mode and a region of interest.

In some exemplary embodiments, the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1. For a definition of TTL and EFL see e,g. co-assigned US published patent application No. 20150244942.

In some exemplary embodiments, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

In some exemplary embodiments, the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting examples of embodiments disclosed herein are described below with reference to figures attached hereto that are listed following this paragraph. Identical structures, elements or parts that appear in more than one figure are generally labeled with a same numeral in all the figures in which they appear. The drawings and descriptions are meant to illuminate and clarify embodiments disclosed herein, and should not be considered limiting in any way.

FIG. 1A shows schematically a block diagram illustrating an exemplary dual-aperture zoom imaging system disclosed herein;

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A:

FIG. 2 shows an example of a Wide sensor, a Tele sensor and their respective FOVs;

FIG. 3A shows an embodiment of an exemplary method disclosed herein for acquiring a zoom image in video/preview mode;

FIG. 3B shows exemplary feature points in an object;

FIG. 3C shows schematically a known rectification process;

FIG. 4 shows a graph illustrating an effective resolution zoom factor.

DETAILED DESCRIPTION

Definitions:

Sharpness score: the gradients (dx, dy) of the image are compared (through subtraction) to the gradients of its low pass filtered version. A higher difference indicates a sharper original image. The result of this comparison is normalized with respect to the average variations (for example, sum of absolute gradients) of the original image, to obtain an absolute sharpness score.

Edge score: for each image, the edges are found (for example, using Canny edge detection) and the average intensity of gradients along them is calculated, for example, by calculating the magnitude of gradients (dx, dy) for each edge pixel, summing the results and dividing by the total number of edge pixels. The result is the edge score.

Effective resolution score: this score is calculated only in a region of interest (ROI) and provides a good indication of the effective resolution level in the image. As used herein, "ROI" is a user-defined sub-region of the image that may be exemplarily 4% or less of the image area. The effective resolution score can be derived from a combination of the sharpness scores and edge scores for each image, for example by normalizing both to be between [0, 1] and by taking their average.

FIG. 1A shows schematically a block diagram illustrating an exemplary embodiment of a dual-aperture zoom imaging system (also referred to simply as “dual-camera” or "dual-aperture camera") disclosed herein and numbered **100**. Dual-aperture camera **100** comprises a Wide imaging section (“Wide camera”) that includes a Wide lens block **102,** a Wide image sensor **104** and a Wide image processor **106.** Dual-aperture camera **100** further comprises a Tele imaging section (“Tele camera”) that includes a Tele lens block **108**, a Tele image sensor **110** and a Tele image processor **112**. The image sensors may be physically separate or may be part of a single larger image sensor. The Wide sensor pixel size can be equal to or different from the Tele sensor pixel size. Dual-aperture camera **100** further comprises a camera fusion processing core (also referred to as “controller”) **114** that includes a sensor control module **116**, a user control module **118,** a video processing module **126** and a capture processing module **128,** all operationally coupled to sensor control block **110**. User control module **118** comprises an operational mode function **120**, a ROI function **122** and a zoom factor (ZF) function **124**.

Sensor control module **116** is connected to the two (Wide and Tele) cameras and to the user control module **118** and used to choose, according to the zoom factor, which of the sensors is operational and to control the exposure mechanism and the sensor readout. Mode choice function **120** is used for choosing capture/video modes. ROI function **122** is used to choose a region of interest. The ROI is the region on which both cameras are focused on. Zoom factor function **124** is used to choose a zoom factor. Video processing module **126** is connected to mode choice function **120** and used for video processing. It is configurable to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data and to make a decision regarding video output. Specifically, upon evaluation of a no-switching criterion, if the no-switching criterion is fulfilled, module **126** is configurable to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value. If the no-switching criterion is not fulfilled, module **126** is configurable to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view. Still processing module **128** is connected to the mode choice function **120** and used for high image quality still mode images. The video processing module is applied when the user desires to shoot in video mode. The capture processing module is applied when the user wishes to shoot still pictures.

FIG. 1B is a schematic mechanical diagram of the dual-aperture zoom imaging system of FIG. 1A. Exemplary dimensions: Wide lens TTL = 4.2mm and EFL = 3.5mm; Tele lens TTL = 6mm and EFL = 7 mm; both Wide and Tele sensors 1/3 inch; external dimensions of Wide and Tele cameras: width (w) and length (l) = 8.5 mm and height (h) = 6.8 mm; distance "d" between camera centers = 10mm.

Following is a detailed description and examples of different methods of use of dual-aperture camera **100**.

Still mode operation/function

In still camera mode, the obtained image is fused from information obtained by both cameras at all zoom levels, see FIG. 2, which shows a Wide sensor **202** and a Tele sensor **204** and their respective FOVs. Exemplarily, as shown, the Tele sensor FOV is half the Wide sensor FOV. The still camera mode processing includes two stages: the first stage includes setting HW settings and configuration, where a first objective is to control the sensors in such a way that matching FOVs in both images (Tele and Wide) are scanned at the same time, a second objective is to control the relative exposures according to the lens properties, and a third objective is to minimize the required bandwidth from both sensors for the ISPs. The second stage includes image processing that fuses the Wide and the Tele images to achieve optical zoom, improves SNR and provides wide dynamic range.

FIG. 3A shows image line numbers vs. time for an image section captured by CMOS sensors. A fused image is obtained by line (row) scans of each image. To prevent matching FOVs in both sensors to be scanned at different times, a particular configuration is applied by the camera controller on both image sensors while keeping the same frame rate. The difference in FOV between the sensors determines the relationship between the rolling shutter time and the vertical blanking time for each sensor.

Video mode operation/function

<u>Smooth transition</u>

When a dual-aperture camera switches the camera output between cameras or points of view, a user will normally see a "jump" (discontinuous) image change. However, a change in the zoom factor for the same camera and POV is viewed as a continuous change. A "smooth transition" (ST) is a transition between cameras or POVs that minimizes the jump effect. This may include matching the position, scale, brightness and color of the output image before and after the transition. However, an entire image position matching between the camera outputs is in many cases impossible, because parallax causes the position shift to be dependent on the object distance. Therefore, in a smooth transition as disclosed herein, the position matching is achieved only in the ROI region while scale brightness and color are matched for the entire output image area.

Zoom-in and Zoom-out in video mode

In video mode, sensor oversampling is used to enable continuous and smooth zoom experience. Processing is applied to eliminate the changes in the image during crossover from one camera to the other. Zoom from 1 to Z_{switch} is performed using the Wide sensor only. From Z_{switch} and on, it is performed mainly by the Tele sensor. To prevent "jumps" (roughness in the image), switching to the Tele image is done using a zoom factor which is a bit higher (Z_{switch} +ΔZoom) than Z_{switch}. ΔZoom is determined according to the system's properties and is different for cases where zoom-in is applied and cases where zoom-out is applied ($\Delta Zoom_{in} \neq \Delta Zoom_{out}$). This is done to prevent residual jumps artifacts to be visible at a certain zoom factor. The switching between sensors, for an increasing zoom and for decreasing zoom, is done on a different zoom factor.

The zoom video mode operation includes two stages: (1) sensor control and configuration and (2) image processing. In the range from 1 to Z_{switch}, only the Wide sensor is operational, hence, power can be supplied only to this sensor. Similar conditions hold for a Wide AF mechanism. From $Z_{switch}+\Delta Zoom$ to Z_{max} only the Tele sensor is operational, hence, power is supplied only to this sensor. Similarly, only the Tele sensor is operational and power is supplied only to it for a Tele AF mechanism. Another option is that the Tele sensor is operational and the Wide sensor is working in low frame rate. From Z_{switch} to $Z_{switch}+\Delta Zoom$, both sensors are operational.

Zoom-in: at low ZF up to slightly above ZF_T (the zoom factor that enables switching between Wide and Tele outputs) the output image is the digitally zoomed, unchanged Wide camera output. ZF_T is defined as follows:

$$ZF_T = \text{Tan}\,(FOV_{Wide})/\text{Tan}\,(FOV_{Tele})$$

where Tan refers to "tangent", while FOV_{Wide} and FOV_{Tele} refer respectively to the Wide and

Tele lens fields of view (in degrees). As used herein, the FOV is measured from the center axis to the corner of the sensor (i.e. half the angle of the normal definition). Switching cannot take place below ZF_T and it can above it.

In some embodiments for the up-transfer ZF, as disclosed in co-invented and co-owned US patent 9,185,291, the output is a transformed Tele camera output, where the transformation is performed by a global registration (GR) algorithm to achieve smooth transition. As used herein "global registration" refers to an action for which the inputs are the Wide and Tele images. The Wide image is cropped to display the same FOV as the Tele image. The Tele image is passed through a low pass filter (LPF) and resized to make its appearance as close as possible to the Wide image (lower resolution and same pixel count). The outputs of GR are corresponding feature point pairs in the images along with their disparities, and parameters for differences between the images, i.e. shift and scale. As used herein, "feature point" refers to a point such as points **10a-d** in FIG. 3B and refers to a point (pixel) of interest on an object in an image. For purposes set forth in this description, a feature point should be reproducible and invariant to changes in image scale, noise and illumination. Such points usually lie on corners or other high-contrast regions of the object.

Stages of Global Registration

In some exemplary embodiments, global registration may be performed as follows:

1. Find interest points (features) in each image separately by filtering it with, exemplarily, a Difference of Gaussians filter, and finding local extrema on the resulting image.

2. Find feature correspondences (features in both images that describe the same point in space) in a "matching" process. These are also referred to as "feature pairs", "correspondence pairs" or "matching pairs". This is done by comparing each feature point from one (Tele or Wide) image (referred to hereinafter as "image 1") to all feature points in that region from the other (respectively Wide or Tele) image (referred to hereinafter as "image 2"). The features are compared only within their group of minima/maxima, using patch normalized cross-correlation. As used herein, "patch" refers to a group of neighboring pixels around an origin pixel.

3. The normalized cross correlation of two image patches $t(x,y)$ and $f(x,y)$ is $\frac{1}{n}\sum_{x,y}\frac{(f(x,y)-\bar{f})(t(x,y)-\bar{t})}{\sigma_f\sigma_t}$ where n is the number of pixels in both patches, $\bar{f}$ is the average of f and σ_f is the standard deviation of f. A match for a feature point from image 1 is only

confirmed if its correlation score is much higher (for example, x1.2) than the next-best matching feature from image 2.

4. Find the disparity between each pair of corresponding features (also referred to as "matching pair") by subtracting their x and y coordinate values.

5. Filter bad matching points:

a. Following the matching process, matches that include feature points from image 2 that were matched to more than one feature from image 1 are discarded.

b. Matching pairs whose disparity is inconsistent with the other matching pairs are discarded. For example, if there is one corresponding pair which whose disparity is lower or higher than the others by 20 pixels.

6. The localization accuracy for matched points from image 2 is refined by calculating a correlation of neighboring pixel patches from image 2 with the target patch (the patch around the current pixel (of the current matching pair) from image 1, modeling the results as a parabola and finding its maximum.

7. Rotation and fine scale differences are calculated between the two images according to the matching points (for example, by subtracting the center of mass from each set of points, i.e. the part of the matching points belonging to either the Wide or the Tele image, and solving a least squares problem).

8. After compensating for these differences, since the images were rectified, the disparity in the Y axis should be close to 0. Matching points that do not fit this criterion are discarded. A known rectification process is illustrated in FIG. 3C.

9. Finally, the remaining matching points are considered true and the disparities for them are calculated. A weighted average of the disparity is taken as the shift between both images. The maximum difference between disparity values is taken as the disparity range.

10. At various stages during GR, if there are not enough feature/matching points remaining, the GR is stopped and returns a failure flag.

In addition, it is possible to find range calibration to the rectification process by finding the shiftI = shift for objects at infinity and defining shiftD=shift-shiftI and disparity D = disparity-shiftI. We then calculate $object\ distance = \frac{focalLength \cdot baseline}{disparityD \cdot pixelSize}$, where "baseline" is the distance between cameras.

Returning now to the Zoom-in process, in some embodiments, for higher ZF than the up-transfer ZF the output is the transformed Tele camera output, digitally zoomed. However, in other embodiments for the up-transfer ZF there will be no switching from the Wide to the

Tele camera output, i.e. the output will be from the Wide camera, digitally zoomed. This "no switching" process is described next.

No Switching

Switching from the Wide camera output to the transformed Tele camera output will be performed unless some special condition (criterion), determined based on inputs obtained from the two camera images, occurs. In other words, switching will not be performed only if at least one of the following no-switching criteria is fulfilled:

1. if the shift calculated by GR is greater than a first threshold, for example 50 pixels.
2. if the disparity range calculated by GR is greater than a second threshold, for example 20 pixels, because in this case there is no global shift correction that will suppress movement/jump for all objects distances (smooth transition is impossible for all objects).
3. if the effective resolution score of the Tele image is lower than that of the Wide image. In this case, there is no point in performing the transition because no value (i.e. resolution) is gained. Smooth transition is possible but undesirable.
4. if the GR fails, i.e. if the number of matching pairs found is less than a third threshold, for example 20 matching pairs.
5. if, for example, that are imaged onto the overlap area are calculated to be closer than a first threshold distance, for example 30 cm, because this can result in a large image shift to obtain ST.
6. if some objects (for example two objects) that are imaged in the overlap area are calculated to be closer than a second threshold distance, for example 50 cm, while other objects (for example two objects) are calculated to be farther than a third threshold distance for example 10 m. The reason is that the shift between an object position in the Wide and Tele cameras is object distance dependent, where the closer the objects the larger the shift, so an image containing significantly close and far objects cannot be matched by simple transformation (shift scale) to be similar and thus provide ST between cameras.

Zoom-out: at high ZF down to slightly below Z_{FT}, the output image is the digitally zoomed transformed Tele camera output. For the down-transfer ZF, the output is a shifted Wide camera output, where the Wide shift correction is performed by the GR algorithm to achieve smooth transition, i.e. with no jump in the ROI region. For lower (than the down-transfer) ZF, the output is basically the down-transfer ZF output digitally zoomed but with gradually smaller Wide shift correction, until for ZF=1 the output is the unchanged Wide camera output.

Note that if a no-switching criterion is not fulfilled, then the camera will output without fusion continuous zoom video mode output images of the object or scene, each output image having a respective output resolution, the video output images being provided with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output resolution is determined by the Wide sensor, and wherein at the higher ZF value the output resolution is determined by the Tele sensor.

FIG. 3A shows an embodiment of a method disclosed herein for acquiring a zoom image in video/preview mode for 3 different zoom factor (ZF) ranges: (a) ZF range = 1 : Z_{switch}; (b) ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$: and (c) Zoom factor range = Z_{switch} + $\Delta Zoom_{in}$: Z_{max}. The description is with reference to a graph of effective resolution vs. zoom factor (FIG. 4). In step **302**, sensor control module **116** chooses (directs) the sensor (Wide, Tele or both) to be operational. Specifically, if the ZF range = 1:Z_{switch}, module **116** directs the Wide sensor to be operational and the Tele sensor to be non-operational. If the ZF range is Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, module **116** directs both sensors to be operational and the zoom image is generated from the Wide sensor. If the ZF range is Z_{switch} + $\Delta Zoom_{in}$: Z_{max}, module **116** directs the Wide sensor to be non-operational and the Tele sensor to be operational. After the sensor choice in step **302,** all following actions are performed in video processing core **126**. Optionally, in step **304,** color balance is calculated if two images are provided by the two sensors. Optionally yet, in step **306**, the calculated color balance is applied in one of the images (depending on the zoom factor). Further optionally, in step **308**, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient can be used to set an AF position in step **310**. In step **312**, an output of any of steps **302-308** is applied on one of the images (depending on the zoom factor) for image signal processing that may include denoising, demosaicing, sharpening, scaling, etc. In step **314**, the processed image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p). To avoid a transition point to be executed at the same ZF, $\Delta Zoom$ can change while zooming in and while zooming out. This will result in hysteresis in the sensor switching point.

In more detail, for ZF range 1: Z_{switch}, for ZF < Z_{switch}, the Wide image data is transferred to the ISP in step **312** and resampled in step **314**. For ZF range = Z_{switch} : Z_{switch} + $\Delta Zoom_{in}$, both sensors are operational and the zoom image is generated from the Wide sensor. The color balance is calculated for both images according to a given ROI. In addition, for a given ROI, registration is performed between the Wide and Tele images to output a transformation coefficient. The transformation coefficient is used to set an AF position. The transformation coefficient includes the translation between matching points in the two images. This translation can be measured in a number of pixels. Different translations will result in a different number of pixel movements between matching points in the images. This movement can be translated into depth and the depth can be translated into an AF position. This enables to set the AF position by only analyzing two images (Wide and Tele). The result is fast focusing.

Both color balance ratios and transformation coefficient are used in the ISP step. In parallel, the Wide image is processed to provide a processed image, followed by resampling. For ZF range = $Z_{switch} + \Delta Zoom_{in} : Z_{max}$ and for Zoom factor > $Z_{switch,} + \Delta Zoom_{in}$, the color balance calculated previously is now applied on the Tele image. The Tele image data is transferred to the ISP in step **312** and resampled in step **314**. To eliminate crossover artifacts and to enable smooth transition to the Tele image, the processed Tele image is resampled according to the transformation coefficient, the requested ZF (obtained from zoom function **124**) and the output video resolution (for example 1080p).

FIG. 4 shows the effective resolution as a function of the zoom factor for a zoom-in case and for a zoom-out case $\Delta Zoom_{up}$ is set when one zooms in, and $\Delta Zoom_{down}$ is set when one zooms out. Setting $\Delta Zoom_{up}$ to be different from $\Delta Zoom_{down}$ will result in transition between the sensors to be performed at different zoom factor ("hysteresis") when zoom-in is used and when zoom-out is used. This hysteresis phenomenon in the video mode results in smooth continuous zoom experience.

In conclusion, dual aperture optical zoom digital cameras and associate methods disclosed herein reduce the amount of processing resources, lower frame rate requirements, reduce power consumption, remove parallax artifacts and provide continuous focus (or provide loss of focus) when changing from Wide to Tele in video mode. They provide a dramatic reduction of the disparity range and avoid false registration in capture mode. They reduce image intensity differences and enable work with a single sensor bandwidth instead of two, as in known cameras.

All patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the present disclosure.

While this disclosure has been described in terms of certain embodiments and generally associated methods, alterations and permutations of the embodiments and methods will be apparent to those skilled in the art. The disclosure is to be understood as not limited by the specific embodiments described herein, but only by the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections, the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

2. The camera of claim 1, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

3. The camera of claim 1, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

4. The camera of claim 1, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

5. The camera of claim 1, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

6. The camera of claim 1, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

7. The camera of claim 1, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

8. The camera of claim 1, wherein the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

9. The camera of claim 8, wherein the user inputs include a zoom factor, a camera mode and a region of interest.

10. The camera of any of the claims 1-9, wherein the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1.

11. The camera of any of the claims 1-9, wherein, if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor.

12. The camera of any of the claims 1-9, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

13. A method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV) and a Wide sensor, a Tele imaging section having a Tele lens with

a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value.

14. The method of claim 13, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

15. The method of claim 13, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

16. The method of claim 13, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

17. The method of claim 13, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

18. The method of claim 13, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

19. The method of claim 13, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third threshold distance.

20. The method of any of the claims 13-19, further comprising the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some

of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

21. The method of any of the claims 13-19, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

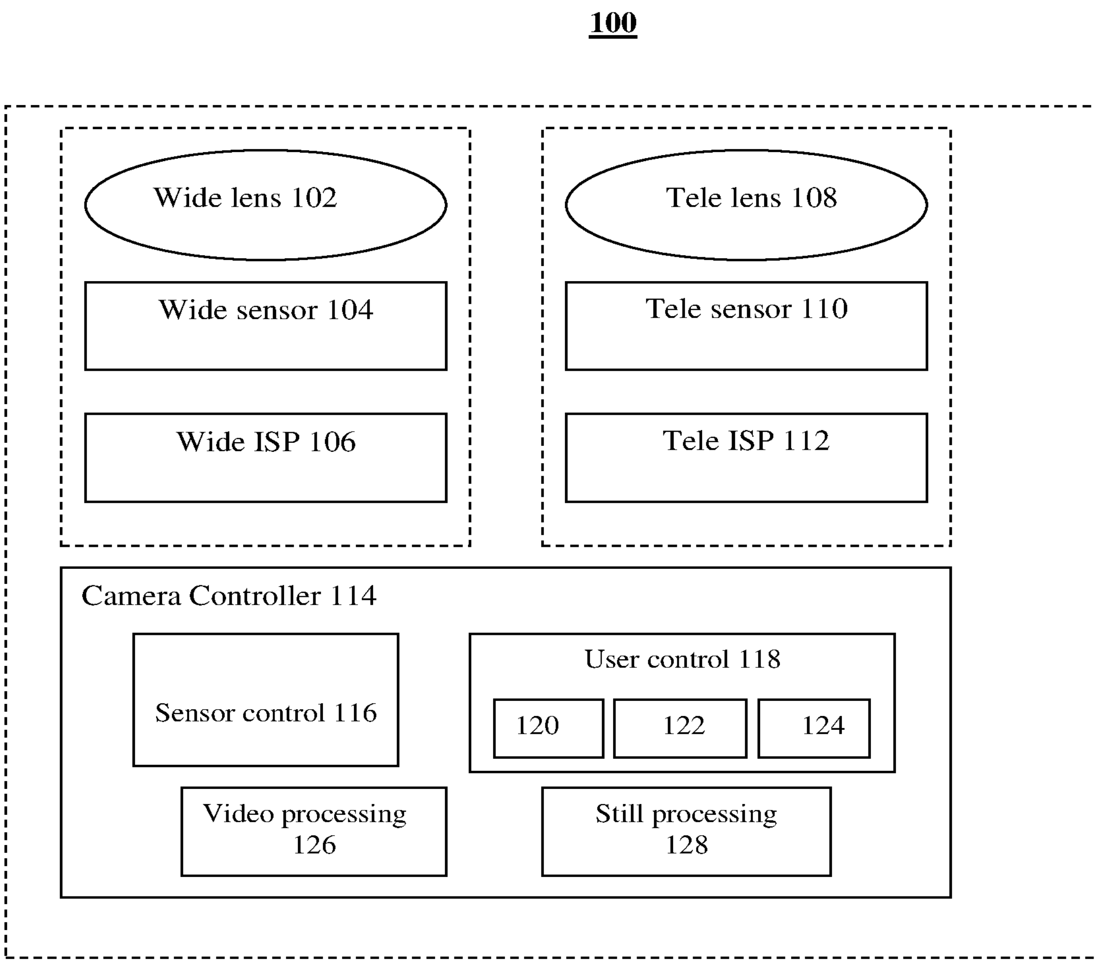
100
Wide lens 102
Tele lens 108
Wide sensor 104
Tele sensor 110
Wide ISP 106
Tele ISP 112
Camera Controller 114
Sensor control 116
User control 118
120
122
124
Video processing 126
Still processing 128

FIG. 1A

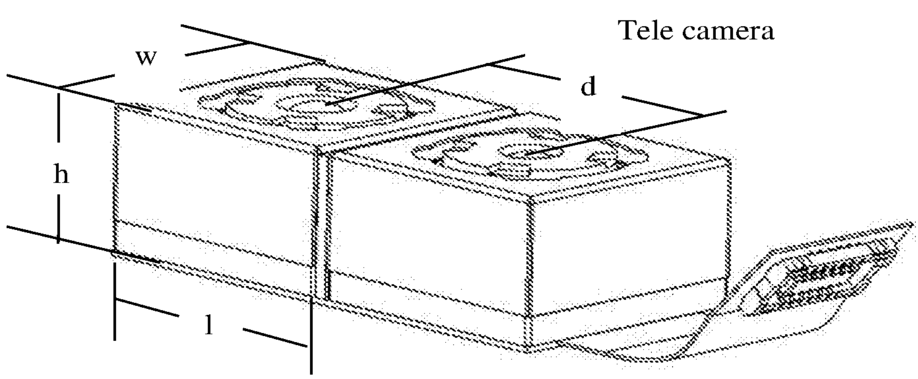
Tele camera
w
d
h
l

FIG. 1B

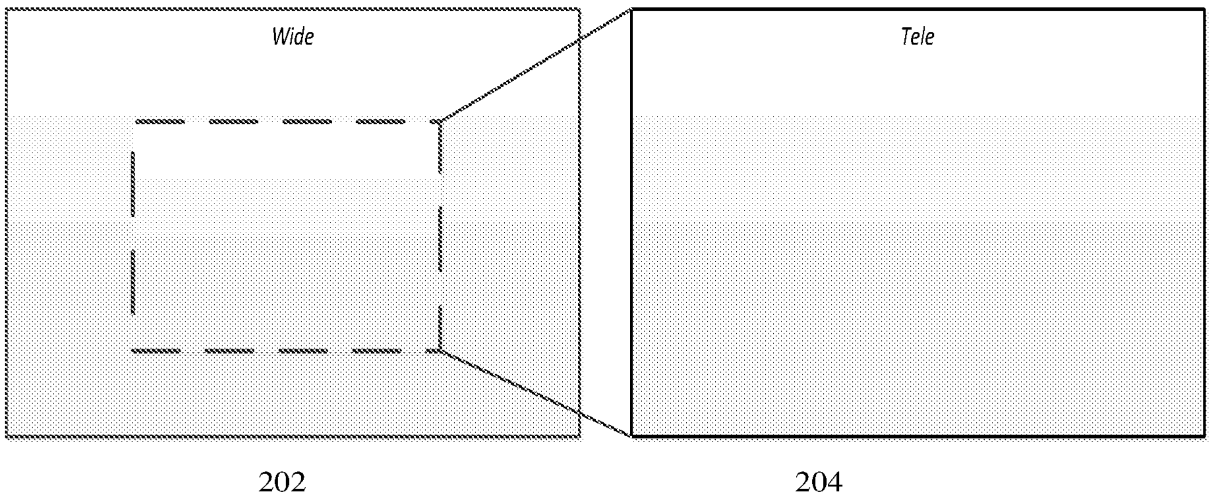

FIG. 2

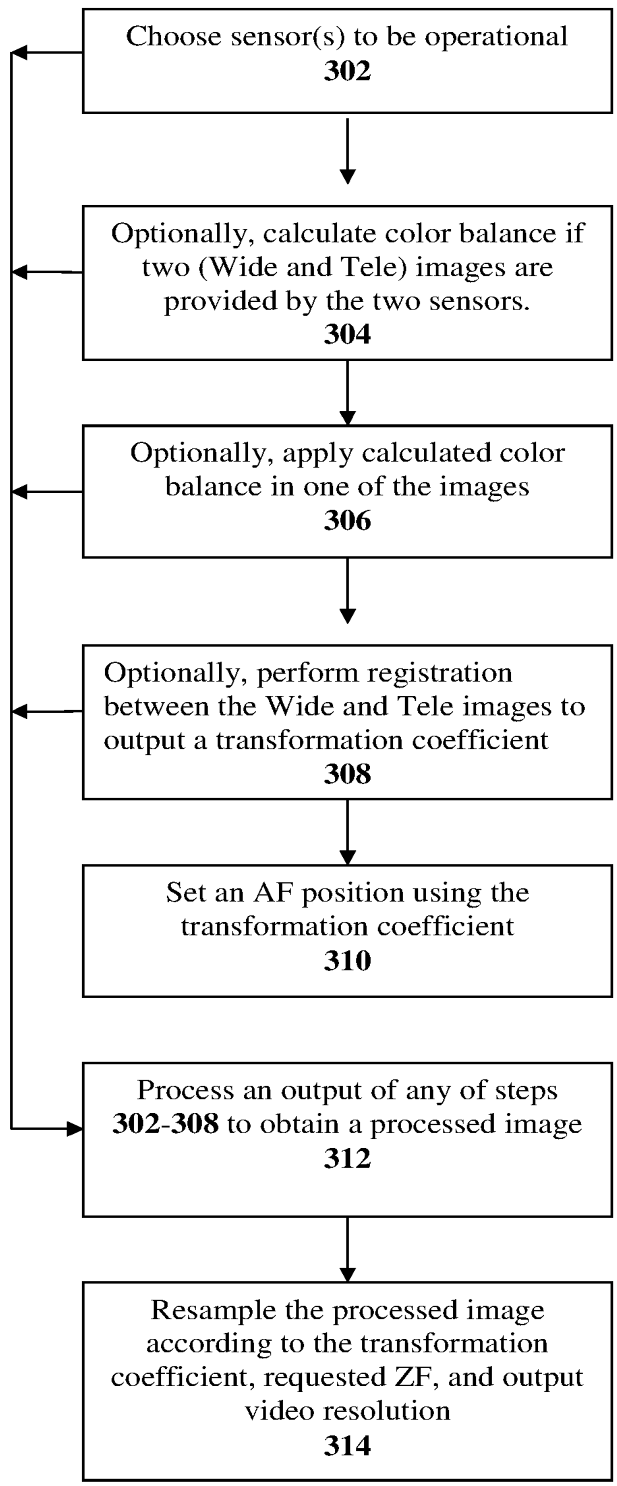
Choose sensor(s) to be operational
302
Optionally, calculate color balance if two (Wide and Tele) images are provided by the two sensors.
304
Optionally, apply calculated color balance in one of the images
306
Optionally, perform registration between the Wide and Tele images to output a transformation coefficient
308
Set an AF position using the transformation coefficient
310
Process an output of any of steps 302-308 to obtain a processed image
312
Resample the processed image according to the transformation coefficient, requested ZF, and output video resolution
314

FIG. 3A

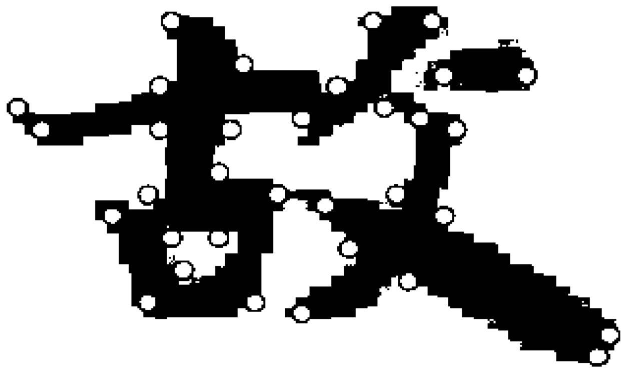

FIG. 3B

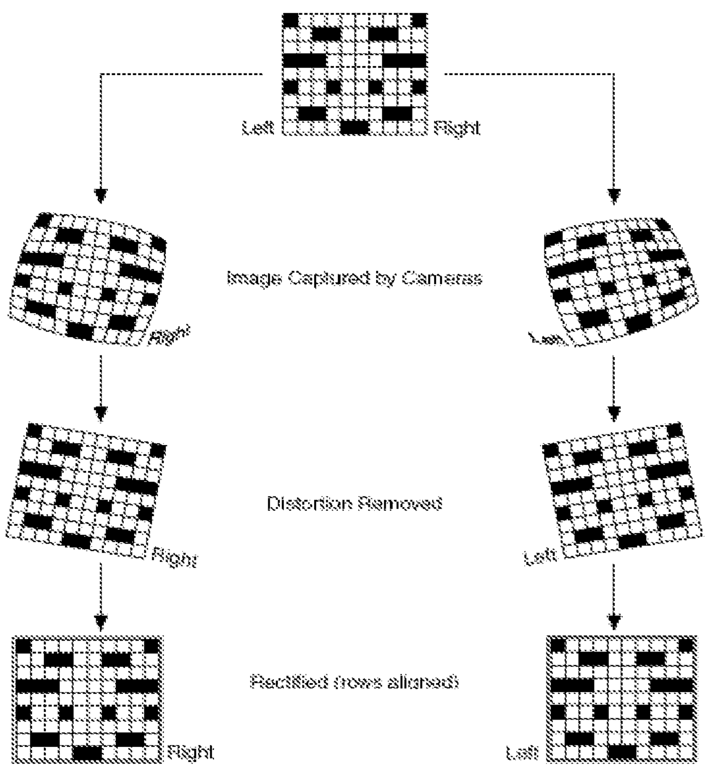
Left
Right
Image Captured by Cameras
Right
Left
Distortion Removed
Right
Left
Rectified (rows aligned)
Right
Left

FIG. 3C

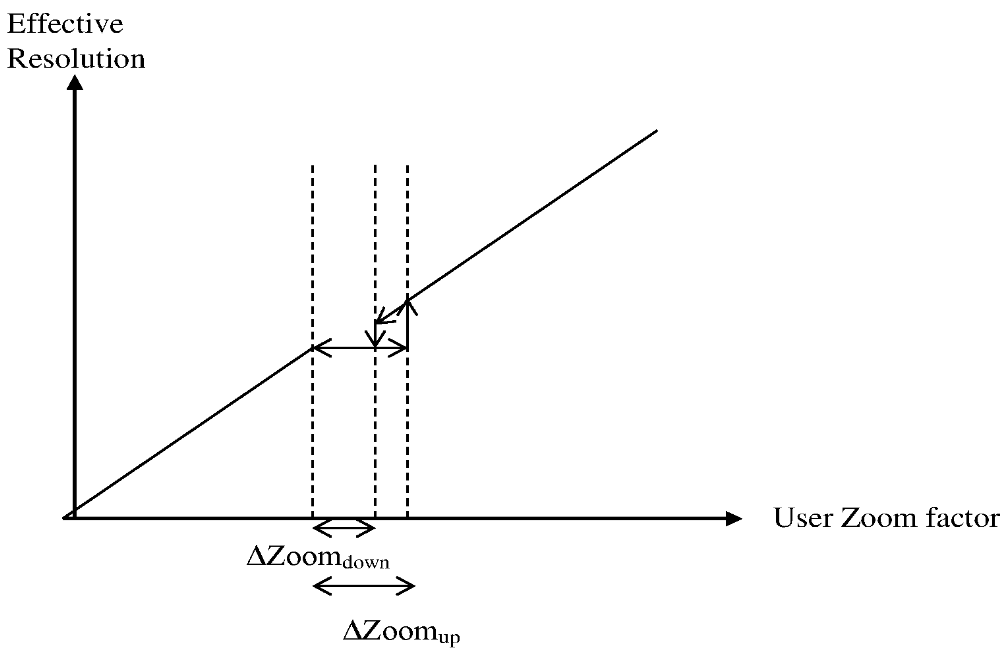

FIG. 4

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
15/324,720	01/08/2017		600	COREPH-0159 US NP	21	2

CONFIRMATION NO. 5811

FILING RECEIPT

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Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

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Power of Attorney: The patent practitioners associated with Customer Number 92342

Domestic Priority data as claimed by applicant

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which claims benefit of 62/204,667 08/13/2015

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 03/17/2018

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 15/324,720**

Projected Publication Date: 06/28/2018

Non-Publication Request: No

Early Publication Request: No
**** SMALL ENTITY ****
Title

DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number
15/324,720

APPLICATION AS FILED - PART I

FOR	NUMBER FILED (Column 1)		NUMBER EXTRA (Column 2)	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A		N/A	N/A	150		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A		N/A	N/A	260		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A		N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	21	minus 20 =	* 1	x 50 =	50	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2	minus 3 =	*	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					0.00			
				TOTAL	840		TOTAL	

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED - PART II

AMENDMENT A

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

AMENDMENT B

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
Application Size Fee (37 CFR 1.16(s))									
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

U.S. APPLICATION NUMBER NO.	FIRST NAMED INVENTOR	ATTY. DOCKET NO.
15/324,720	Noy Cohen	COREPH-0159 US NP

92342
Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

INTERNATIONAL APPLICATION NO.	
PCT/IB2016/053803	
I.A. FILING DATE	PRIORITY DATE
06/26/2016	08/13/2015

CONFIRMATION NO. 5811
371 ACCEPTANCE LETTER

OC000000098143721

Date Mailed: 03/20/2018

NOTICE OF ACCEPTANCE OF APPLICATION UNDER 35 U.S.C 371 AND 37 CFR 1.495

The applicant is hereby advised that the United States Patent and Trademark Office, in its capacity as a Designated / Elected Office (37 CFR 1.495), has ACCEPTED the above identified international application for national patentability examination in the United States Patent and Trademark Office.

The United States Application Number assigned to the application is shown above. A Filing Receipt will be issued for the present application in due course. **THE DATE APPEARING ON THE FILING RECEIPT AS THE "FILING DATE or 371(c) DATE" IS THE DATE ON WHICH THE LAST OF THE 35 U.S.C. 371 (c)(1) and (c)(2) REQUIREMENTS HAS BEEN RECEIVED IN THE OFFICE. THIS DATE IS SHOWN BELOW.** The filing date of the above identified application is the international filing date of the international application (Article 11(3) and 35 U.S.C. 363)

<u>01/08/2017</u>
DATE OF RECEIPT OF 35 U.S.C.
371(c)(1) and (c)(2) REQUIREMENTS

The following items have been received:

- Indication of Small Entity Status
- Copy of the International Application filed on 01/08/2017
- Copy of the International Search Report filed on 01/08/2017
- Preliminary Amendments filed on 01/08/2017
- Information Disclosure Statements filed on 01/08/2017
- Inventor's Oath or Declaration filed on 01/08/2017
- U.S. Basic National Fees filed on 01/08/2017
- Assignment filed on 01/08/2017
- Authorize Access to Search Results filed on 01/08/2017
- Priority Documents filed on 01/08/2017
- Power of Attorney filed on 01/08/2017
- Authorization to Permit Access filed on 01/08/2017
- Application Data Sheet (37 CFR 1.76) filed on 01/08/2017

Applicant is reminded that any communications to the United States Patent and Trademark Office must be mailed to the address given in the heading and include the U.S. application no. shown above (37 CFR 1.5)

ROSA M WEST

Telephone: (571) 272-1019

MULTIPLE DEPENDENT CLAIM FEE CALCULATION SHEET Substitute for Form PTO-1360 (For use with Form PTO/SB/06)	Application Number 15324720	Filing Date
	Applicant(s) Noy Cohen	
	* May be used for additional claims or amendments	

CLAIMS	AS FILED		AFTER FIRST AMENDMENT		AFTER SECOND AMENDMENT	
	Indep	Depend	Indep	Depend	Indep	Depend
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Total Indep	2		2		0	
Total Depend	55		19		0	
Total Claims	57		21		0	

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

92342 7590 06/19/2018
Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

EXAMINER
TRAN, NHAN T

ART UNIT	PAPER NUMBER
2664	

NOTIFICATION DATE	DELIVERY MODE
06/19/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

info@natpatent.com
mnathan@post.tau.ac.il
talya.nathan@gmail.com

PTOL-90A (Rev. 04/07)

Office Action Summary	Application No. 15/324,720	Applicant(s) COHEN ET AL.	
	Examiner NHAN T. TRAN	Art Unit 2664	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *1/8/2017*.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-21* is/are pending in the application.
5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6)☐ Claim(s) _____ is/are allowed.

7)☒ Claim(s) *1,2,8-11,13,14,20 and 21* is/are rejected.

8)☒ Claim(s) *3-7 and 15-19* is/are objected to.

9)☐ Claim(s) _____ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☒ The drawing(s) filed on *1/8/2017* is/are: a)☒ accepted or b)☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.
2.☐ Certified copies of the priority documents have been received in Application No. _____.
3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☒ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

4) ☐ Other: _____.

DETAILED ACTION

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Information Disclosure Statement

1. The information disclosure statement (IDS) submitted on 1/8/2017 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Claim Rejections - 35 USC § 102

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

3. Claims 1, 2, 4, 8-14, 20 and 21 are rejected under 35 U.S.C. 102(a)(1) as being anticipated by Shabtay et al. (WO 2014/199338, hereinafter "Shabtay", cited in the IDS dated 1/8/2017).

Regarding claim 1, Shabtay discloses a zoom digital camera (Figs. 1 & 2) comprising:

a) a Wide imaging section (102/104/106) that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene (Fig. 1A; page 4, lines 4-17; page 6, lines 23-35 and page 7, lines 28-33);

b) a Tele imaging section (108/110/112) that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene (Fig. 1A; page 4, lines 4-17; page 6, lines 23-35 and page 7, lines 28-33); and

c) a camera controller (114) operatively coupled to the Wide and Tele imaging sections (see Fig. 1A and page 8, lines 1-6), the camera controller configured to evaluate a no-switching criterion determined by inputs from both Wide and Tele image data, and, if the no-switching criterion is fulfilled, to output a zoom video output image that includes only Wide image data in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value *(see page 14, lines 11-34, wherein a no-switching criterion is met when the zoom factor is within the range of 1 to Zswitch (or slightly above ZFT), the zoom video is only output from the Wide sensor using digital zoom. The Tele sensor is not operational in this mode).*

Regarding claim 2, it is also seen in Shabtay that the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold *(see page 13, lines 10-14 and page 14, lines 11-34. It should be noted that the first threshold is considered as ZF in the still image mode, and 1 to Zswitch in the video mode, wherein "global registration" is given its* *broadest reasonable interpretation as the registration of the above thresholds that have been programmed beforehand in the camera).*

Regarding claim 8, Shabtay further discloses that the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs (see Fig. 1A, user control 118; page 8, lines 5-6).

Regarding claim 9, as also seen in Shabtay, the user inputs include a zoom factor (ZF), a camera mode and a region of interest (page 8, lines 5-6).

Regarding claim 10, Shabtay also clearly discloses that the Tele lens includes a ration of total track length (TTL)/effective focal length (EFL) smaller than 1 *(see page 8, lines 20-21 in which TTL= 6mm and EFL= 7mm).*

Regarding claim 11, it is also seen in Shabtay that if the no-switching criterion is not fulfilled, the camera controller is further configured to output video output images with a smooth transition when switching between the lower ZF value and the higher ZF value or vice versa, wherein at the lower ZF value the output image is determined by the Wide sensor, and wherein at the higher ZF value the output image is determined by the Tele sensor (see Fig. 6 and page 15, lines 8-20).

Regarding claim 12, Shabtay further discloses that the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view *(see page 13, lines 5-27, wherein in a still image mode, a fused output image is obtained using both Wide image data and Tele image data for a predetermined range of ZF values).*

Regarding claims 13, 14 & 20, the subject matter of these claims are met by Shabtay as discussed in claims 1, 2 and 12, respectively.

Regarding claim 21, Shabtay also discloses that the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas (see claim 17 in Shabtay).

Allowable Subject Matter

4. Claims 3-7 and 15-19 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

5. The following is a statement of reasons for the indication of allowable subject matter:

The prior art of record fails to teach or fairly suggest the limitations of each of claims 3-7 and 15-19. The Examiner has found no teaching, support and/or reason that render these claims obvious over the disclosure of Shabtay reference in view of the whole prior art of record. Shabtay and other teachings provide no disclosure for the no-switching criterion setting as clearly defined by each of claims 3-7. For claims 15-19, the same reason is applied as these claims recite similar method limitations as in the apparatus claims 3-7.

Conclusion

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NHAN T. TRAN whose telephone number is (571)272-7371. The examiner can normally be reached on Monday - Friday 8:30AM - 5:00PM.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner’s supervisor, Lin Ye can be reached on 571-272-7372. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/NHAN T TRAN/
Primary Examiner, Art Unit 2664

Notice of References Cited	Application/Control No. 15/324,720	Applicant(s)/Patent Under Reexamination COHEN ET AL.	
	Examiner NHAN T. TRAN	Art Unit 2664	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-2007/0025713 A1	02-2007	Hosono; Eiji	H04N5/2259	396/72
*	B	US-2007/0182833 A1	08-2007	Toyofuku; Toshiyuki	H04N5/232	348/240.3
*	C	US-2010/0277619 A1	11-2010	Scarff; Lawrence	H04N5/2258	348/240.1
*	D	US-2014/0253693 A1	09-2014	Shikata; Yasuhito	H04N5/23245	348/47
*	E	US-2014/0267834 A1	09-2014	AOKI; Takato	H04N5/23296	348/240.1
*	F	US-2015/0085174 A1	03-2015	Shabtay; Gal	H04N5/23296	348/336
*	G	US-2016/0241793 A1	08-2016	Ravirala; Narayana Karthik	H04N5/23296	1/1
	H	US-				
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	J	US-				
	K	US-				
	L	US-				
	M	US-				

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS

Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	8401276	B1	2013-03-19	Choe et al.	
	2	6104432	A	2000-08-15	Nakamura et al.	
	3	5710670	A	1998-01-20	Ohno	
	4	9185291	B1	2015-11-10	Shabtay et al.	

If you wish to add additional U.S. Patent citation information please click the Add button. Add

U.S.PATENT APPLICATION PUBLICATIONS

Remove

Examiner Initial*	Cite No	Publication Number	Kind Code1	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	20030017930	A1	2003-09-25	Bittner	
	2	20090102950	A1	2009-04-23	Ahiska	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.T./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	3	20080030592	A1	2008-02-07	Border et al.	
	4	20100277619	A1	2010-11-04	Lawrence Scarff	
	5	20110064327	A1	2011-03-17	Joseph C. Dagher et al.	
	6	20150244942	A1	2015-08-27	Shabtay et al.	

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number3	Country Code2 i	Kind Code4	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T5
	1	2014199338	WO	A2	2014-12-18	Corephotonics Ltd.		

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc), date, pages(s), volume-issue number(s), publisher, city and/or country where published.	T5
	1	International Search Report and Written Opinion issued in relation to PCT patent application PCT/IB2016/053803 dated June 26, 2016, 9 pages.	

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/NHAN T TRAN/	Date Considered	06/10/2018

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.T./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number		15324720
	Filing Date		2017-01-08
	First Named Inventor	Noy Cohen	
	Art Unit		
	Examiner Name		
	Attorney Docket Number		COREPH-0159 US NP

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.T./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Menachem Nathan/	Date (YYYY-MM-DD)	2017-01-08
Name/Print	MENACHEM NATHAN	Registration Number	65392

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.T./

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these record s.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.T./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	0	("15324720").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/10 16:31
S2	10660	H04N5/23296.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S3	6676	H04N5/2258.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S4	10722	H04N5/23216.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S5	12379	H04N5/23245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S6	23	"2014199338"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:17
S7	6	"20030017930"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:29
S8	6	(("20030017930") or ("20090102950") or ("20080030592") or ("20100277619") or ("20110064327") or ("20150244942")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/11 11:30
S9	1	("20030179303").PN.	US-PGPUB;	OR	OFF	2018/06/11

			USPAT; USOCR			11:32
S10	4	(("8401276") or ("6104432") or ("5710670") or ("9185291")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/11 11:34
S11	4890	(wide near1 angle or wide) same lens same (telephoto or tele) same (dual or two) same (lens or imag$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:37
S12	3503	S11 same zoom$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:37
S13	287	S12 same (switch$3 or transition$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:38
S14	256	S13 and @ad<"20150813"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:38
S15	9	(transition$3 or switch$3 or shift$3) near3 digital near2 zoom$4 with (telephoto or tele) near3 (lens or optical or imag$3 near2 sens$3 or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:09
S16	74503	fixed near1 focal with wide wth (telephoto or tele) same (dual or two)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:36
S17	3561	(transition$3 or switch$3 or shift$3) with wide with (tele or telephoto or zoom$4 adj1 in)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:36
S18	502	S16 same S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:37

S19	32	S18 same (digital or electronic) near2 (zoom or magnification)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:38
S20	150	fixed with wide with (tele or telephoto) with (dual or two) with (lens or optic$3 or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 13:35
S21	18	S20 same (switch$3 or transition$3 or shift$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 13:35
S22	293	(shift$3 near3 image) with wide with (tele or telephoto)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:19
S23	0	S22 same (registration or register) with global	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:20
S24	4	S22 and (registration or register) with global	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:20
S25	37579	(disparity or misalign$4) with image	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:21
S26	274	switch$3 near2 (camera or tele or telephoto or long near1 focal) with resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 15:42
S27	0	S26 with (digital near1 zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/06/12 16:15

			DERWENT; IBM_TDB			
S28	0	S26 with ((digital or electronic) near1 zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:15
S29	49	(wide or short near2 focal) near2 (camera or lens or optic$3) with (tele or telephoto or long near2 focal) with (switch$3 or transition$3 or shift$3) with condition	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:17
S30	431	(wide or short near2 focal) near2 (camera or lens or optic$3) with (tele or telephoto or long near2 focal) with (switch$3 or transition$3 or shift$3) with (condition or zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:17
S31	7	S30 same (digital or electronic) near2 (zoom$4 or magnification or enlargement) with resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:18
S32	145	resolution with (wide or short near1 focal) near2 imag$3 with (tele or telephoto or long near1 focal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:21
S33	1	S32 same threshold	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:21
S34	49	(dual near2 (camera or imag$3 near2 sens$3) with wide with (tele or telephoto))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:23
S35	27	S34 and resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:24
S36	0	("14386823").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 16:24

S37	1	("20150085174").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 16:25
S38	1	("9800798").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 17:28
S39	16	("20020152557" | "20060139463" | "20060187312" | "20060187338" | "20070025713" | "20080024596" | "20080030592" | "20090295949" | "20110249086" | "20130235234" | "20130250159" | "20140184854" | "20140232905" | "5870139" | "7561191" | "8456515").PN. OR ("9800798").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/12 17:28
S40	5	S34 and (disparity or parallax or misalign$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:38
S41	5	effective near2 resolution with image with (digital or electronic) near2 zoom$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:44
S42	147	detect$3 near2 (object or subject or feature) near3 (clos$3 or short adj1 distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S43	0	S42 with (switch$3 or chang$3 or shift$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S44	0	S42 same (switch$3 or chang$3 or shift$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S45	4797	(object or subject or feature) near3 (clos$2 or short adj1 distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:50
S46	1	S45 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 (lens or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	ON	2018/06/12 17:50

			DERWENT; IBM_TDB			
S47	47	S45 and (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 (lens or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:51
S48	0	S45 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:53
S49	4978	(object or subject or feature or target) near3 clos$2 near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:55
S50	0	S49 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:06
S51	2278	(detect$3 or determin$3 or if or when) near2 (object or subject or feature or target) near3 (clos$2 or distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:07
S52	0	S51 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:08
S53	0	S51 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:08
S54	10	(switch$3 or shift$3 or chang$3) near3 (wide or short near2 focal) near3 (zoom$3 or close-up or closeup or long near1 focal) with (detect$3 near3 (object or subject or target))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:17
L2	1	("20090022276").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 22:35

L11	311	(Cohen near2 Noy or Gigushinski near2 Oded or GEva near1 Nadav or Shabtay near1 Gal or Ashkenazi near2 Ester or Katz near1 Ruthy or Goldenberg near1 Ephraim).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/13 00:00

EAST Search History (Interference)

<This search history is empty>

6/13/2018 12:01:12 AM
C:\Users\ntran1\Documents\EAST\Workspaces\15324720.wsp

Bibliographic Data

Application No: 15/324,720

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /NHAN T TRAN/

Examiner's Signature | Initials

Title: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/08/2017	348	2664	COREPH-0159 US NP
RULE			

APPLICANTS

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Ruthy Katz Tel Aviv, ISRAEL

Ephraim Goldenberg Ashdod, ISRAEL

CONTINUING DATA

This application is a 371 of PCT/IB2016/053803 06/26/2016

PCT/IB2016/053803 has PRO of 62204667 08/13/2015

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

03/17/2018

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STATE OR COUNTRY

ISRAEL

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P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

FILING FEE RECEIVED

$600

Search Notes	Application/Control No. 15324720	Applicant(s)/Patent Under Reexamination COHEN ET AL.
	Examiner NHAN T TRAN	Art Unit 2664

CPC- SEARCHED

Symbol	Date	Examiner
H04N5/23296; H04N5/2258; H04N5/23216; H04N5/23245	6/10/2018	NT

CPC COMBINATION SETS - SEARCHED

Symbol	Date	Examiner

US CLASSIFICATION SEARCHED

Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

SEARCH NOTES

Search Notes	Date	Examiner
EAST search in all available databases (see search history)	6/10/2018	NT
EAST text search in all groups and subgroups (see search history)	6/11/2018	NT
Inventorship search	6/11/2018	NT

INTERFERENCE SEARCH

US Class/ CPC Symbol	US Subclass / CPC Group	Date	Examiner

Index of Claims	Application/Control No. 15324720	Applicant(s)/Patent Under Reexamination COHEN ET AL.
	Examiner NHAN T TRAN	Art Unit 2664

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	06/12/2018								
	1	✓								
	2	✓								
	3	O								
	4	O								
	5	O								
	6	O								
	7	O								
	8	✓								
	9	✓								
	10	✓								
	11	✓								
	12	✓								
	13	✓								
	14	✓								
	15	O								
	16	O								
	17	O								
	18	O								
	19	O								
	20	✓								
	21	✓								

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP

CONFIRMATION NO. 5811

PUBLICATION NOTICE

OC000000100625588

92342
Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

Title:DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

Publication No.US-2018-0184010-A1
Publication Date:06/28/2018

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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Office of Data Managment, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9286680	B1	2016-03-15	Jiang et al.	
	2	9736391	B2	2017-08-15	Du et al.	
	3	9894287	B2	2018-02-13	Qian et al.	
	4	6750903	B1	2004-06-15	Miyatake et al.	
	5	5032917	A	1991-07-16	Felix Aschwanden	
	6	5287093	A	1994-02-15	Amano et al.	
	7	5287093	A	1995-02-28	John T. Hall	
	8	5444478	A	1995-08-22	Lelong et al.	

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First Named Inventor	Noy Cohen
Art Unit	
Examiner Name	
Attorney Docket Number	COREPH-0159 US NP

	9	5657402	A	1997-08-12	Bender et al.	
	10	5682198	A	1997-10-28	Katayama et al.	
	11	5926190	A	1999-07-20	Turkowski et al.	
	12	6128416	A	2000-10-03	Koutatsu Oura	
	13	6148120	A	2000-11-14	Michael Sussman	
	14	6208765	B1	2001-03-27	James Russell Bergen	
	15	7002583	B2	2006-02-21	Maurice F. Rabb, III	
	16	7346217	B1	2008-03-18	V. Edward Gold, Jr.	
	17	7424218	B2	2008-09-09	Baudisch et al.	
	18	7533819	B2	2009-05-19	Barkan et al.	
	19	7619683	B2	2009-11-17	Raymond A. Davis	

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Examiner Name	
Attorney Docket Number	COREPH-0159 US NP

	20	6268611	B1	2001-07-31	Pettersson et al.	
	21	6714665	B1	2004-03-30	Hanna et al.	
	22	5005083	A	1991-04-02	Grage et al.	
	23	5940641	A	1999-08-17	McIntyre et al.	
	24	6741250	B1	2004-05-25	Furlan et al.	
	25	7365793	B2	2008-04-29	Cheatle et al.	
	26	9413930	B2	2016-08-09	Joergen Geerds	
	27	4199785	A	1980-04-22	McCullough et al.	
	28	8400555	B1	2013-03-19	Georgiev et al.	
	29	8553106	B2	2013-10-08	Lawrence Scarff	
	30	9800798	B2	2017-10-24	Ravirala et al.	

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	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	31	5768443	A	1998-06-16	Michael et al.	
	32	6101334	A	2000-08-08	Stephen D. Fantone	
	33	6611289	B1	2003-08-26	Yu et al.	
	34	7015954	B1	2006-03-21	Foote et al.	
	35	7256944	B2	2007-08-14	Labaziewicz et al.	
	36	8587691	B2	2013-11-19	Yasuo Takane	
	37	8274552	B2	2012-09-25	Dahi et al.	
	38	8390729	B2	2013-03-05	Long et al.	
	39	8803990	B2	2014-08-12	Scott Smith	
	40	9270875	B2	2016-02-23	Brisedoux et al.	
	41	9485432	B1	2016-11-01	Medasani et al.	

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	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	42	5436660	A	1995-07-25	Yukio Sakamoto	
	43	6549215	B2	2003-04-15	Norman P. Jouppi	
	44	7411610	B2	2008-08-12	Michael Doyle	
	45	8439265	B2	2013-05-14	Ferren et al.	
	46	5248971	A	1993-09-28	William J. Mandl	
	47	5459520	A	1995-10-17	Tadao Sasaki	
	48	7038716	B2	2006-05-02	Klein et al.	
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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

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Name/Print	Menachem Nathan	Registration Number	65392

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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	COREPH-0159 US NP
First Named Inventor	Noy Cohen
Title	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NO
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

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Electronic Acknowledgement Receipt

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Application Number:	15324720
International Application Number:	
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Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Control method for multi-lens camera and multi-lens device

Abstract

Disclosed is an improved device provided with a multi-lens and multi-sensor camera module. The device has a new mechanism for adjusting multiple lenses and angles of sensors. The new device makes each lens integrated with perspective of the sensors by using a new principle so that images composited by a multi-lens module have high quality and satisfactory properties such as high resolution, high depth of field, high color saturation, high signal-to-noise ratio, high dynamic range, high sensitivity and the like.

CN102739949A

CN Application

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Other languages: Chinese

Inventor: Zhang Kerun

Original Assignee: Zhang Kerun

Priority date : 2011-04-01

Family: CN (1)

Date	App/Pub Number	Status
2011-04-01	CN 201110082063	
2012-10-17	CN102739949A	Application

Double camera control device, method and system of mobile terminal and mobile terminal

Abstract

The invention is suitable for camera control technology and provides a double camera control device of a mobile terminal. The mobile terminal comprises a first camera, a second camera, a power supply unit and a control chip, the power supply unit respectively supplies power for the first camera and the second camera in single mode, and the control chip is respectively communicated with the first camera and the second camera in single mode. The double camera control device of the mobile terminal enables two cameras to be power-supplied and communicated individually and avoids mutual interference of control of the two cameras. In use, users can select opening of singular camera and can also open two cameras simultaneously to preview and shoot at the same time, after shooting, pictures of the double camera can be combined, and accordingly shooting experience of the users is well improved.

CN103024272A

CN Application

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Other languages: Chinese

Inventor: Gao Xiaowen

Original Assignee: Guangdong Opal Mobile Communication Co., Ltd.

Priority date : 2012-12-14

Family: CN (1)

Date	App/Pub Number	Status
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(54) Handheld electronic device with dual image capturing method and computer program product

(57) A handheld electrical device includes a first lens module with a first image capturing boundary, a second lens module with a second image capturing boundary, an input unit and a control unit. The first image capturing boundary is different from the second image capturing boundary. The input unit receives a user input for capturing images. When the input unit receives the user input, the control unit controls the first lens module and the second lens module to respectively capture a first image and a second image at the same time.

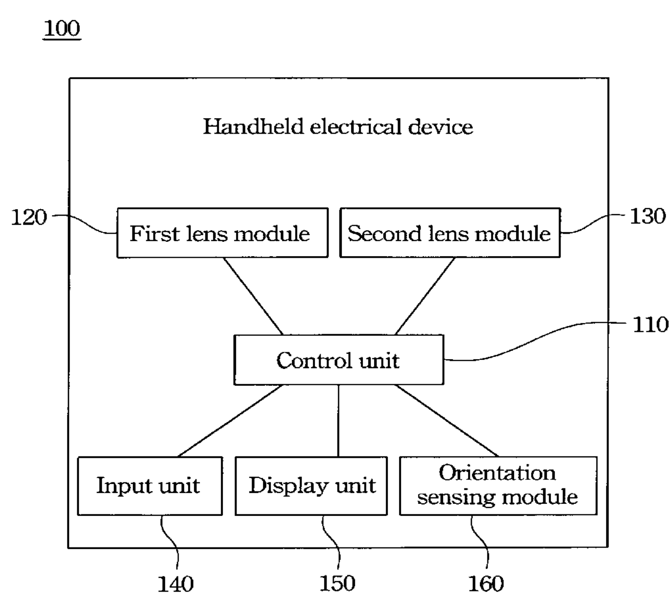

Fig. 2

EP 2 523 450 A1

Description

BACKGROUND

Technical Field

[0001] The present invention relates to an electrical device, an image capturing method and a computer program product for loading into thereof. More particularly, the present invention relates to a handheld electrical device, a dual image capturing method and a computer program product for loading into thereof.

Description of Related Art

[0002] As 3C (Computer, Communications and Consumer) technology develops, there are more and more people utilizing handheld electrical devices in their daily life. Most common handheld electrical devices are personal digital assistants (PDA), mobile phones, smart phones etc. Since mobile electrical devices are designed much smaller and easy to carry, more and more people use handheld electrical device and more functions are developed for different users.

[0003] Nowadays, most handheld electrical devices are equipped with cameras. Wherein, images captured and output by such cameras are landscape images (or called landscape images). If users want images output vertically (as portrait images), the images must be reduced or cut since the width/length ratio of the portrait image and that of the landscape image are different. However, users may not be satisfied with the portrait images after reduce or cut. In particular, when the images captured are video, distortion of the portrait images (videos) thereof may be more obviously since the image may be further trans-coded, which may disturbs users.

SUMMARY

[0004] According to one embodiment of this invention, a handheld electrical device is provided. When a user wants to utilize the handheld electrical device to capture images, the handheld electrical device controls different lens modules, image capturing boundaries of which are different, to capture images with the different image capturing boundaries at the same time. The handheld electrical device includes a first lens module with a first image capturing boundary, a second lens module with a second image capturing boundary, an input unit and a control unit. The first lens module and the second lens module are disposed on the handheld electrical device respectively. Wherein, the first image capturing boundary and the second image capturing boundary are different. The input unit is configured to receive a user input for capturing images. When the input unit receives the user input, the control unit controls the first lens module and the second lens module to respectively capture a first image and a second image at the same time.

[0005] According to another embodiment of this invention, a dual image capturing method is provided. In the dual image capturing method, when a user wants to utilize a handheld electrical device to capture images, the handheld electrical device controls different lens modules, image capturing boundaries of which are different, to capture images with the different image capturing boundaries at the same time. The dual image capturing method is suitable for a handheld electrical device. The handheld electrical device includes a first lens module with a first image capturing boundary and a second lens module with a second image capturing boundary. Wherein, the first image capturing boundary and the second image capturing boundary are different. The dual image capturing method can be implemented as a computer program product, which includes at least one program instruction. The at least one program instruction of the computer program product is used for being loaded into the handheld electrical device. After the at least one program instruction of the computer program product is loaded into the handheld electrical device, the handheld electrical device executes the steps of the dual image capturing method. The dual image capturing method includes the following steps: a user input for capturing images is received. When the user input is received, a first image and a second image are captured at the same time by the first lens module and the second lens module respectively.

[0006] Above all, the handheld electrical device can capture images in different image capturing boundaries at the same time without moving the handheld electrical device. Hence, when capturing images occurring in a flash, images in different image capturing boundaries can be captured to avoid missing any of the boundaries. Besides, if the images captured by the handheld electrical device are videos, the user can switch between portrait images and landscape images without too much image distortion.

[0007] These and other features, aspects, and advantages of the present invention will become better understood with reference to the following description and appended claims. It is to be understood that both the foregoing general description and the following detailed description are by examples, and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The invention can be more fully understood by reading the following detailed description of the embodiments, with reference made to the accompanying drawings as follows:

Fig. 1 is a rear-view diagram of a handheld electrical device according to one embodiment of this invention;

Fig. 2 is a block diagram of the handheld electrical device in Fig. 1;

Fig. 3 illustrates a front-view diagram of the handheld electrical device in Fig. 1 in a portrait orientation;

Fig. 4 illustrates a front-view diagram of the handheld electrical device in Fig. 1 in a landscape orientation;

Fig. 5 illustrates an embodiment of the indication line displayed on the handheld electrical device 100 in Fig. 1;

Fig. 6 illustrates another embodiment of the indication line displayed on the handheld electrical device 100 in Fig. 1;

Fig. 7 illustrates an embodiment of the miniature displayed on the handheld electrical device 100 in Fig. 1;

Fig. 8 illustrates another embodiment of the miniature displayed on the handheld electrical device 100 in Fig. 1; and

Fig. 9 is a flow diagram of a dual image capturing method according to one embodiment of this invention.

DETAILED DESCRIPTION

[0009] Reference will now be made in detail to the present embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the description to refer to the same or like parts.

[0010] Fig. 1 is a rear-view diagram of a handheld electrical device according to one embodiment of this invention. Fig. 2 is a block diagram of the handheld electrical device in Fig. 1. When a user wants to utilize the handheld electrical device to capture images, the handheld electrical device controls different lens modules, image capturing boundaries of which are different, to capture images with the different image capturing boundaries at the same time.

[0011] The handheld electrical device 100 includes a control unit 110, a first lens module 120, a second lens module 130, and an input unit 140. The first lens module 120 and the second lens module 130 are disposed on the handheld electrical device 100 respectively. The first lens module 120, the second lens module 130, and the input unit 140 are electrically connected to the control unit 110. The input unit 140 may be at least one button, a keyboard, a graphical user interface (GUI) or other types of input units.

[0012] The first lens module 120 can capture scenes with a first image capturing boundary. The second lens module 130 can capture scenes with a second image capturing boundary. Wherein, the first image capturing boundary and the second image capturing boundary are different. The input unit 140 is configured to receive a user input for capturing images. When the input unit 140 receives the user input, the control unit 110 controls the first lens module 120 and the second lens module 130 to respectively capture a first image and a second image at the same time. Wherein, the first image and the second image may include pictures, videos or other types of image. Therefore, the handheld electrical device 100 can capture images in different image capturing boundaries at the same time without moving the handheld electrical device 100. Hence, when capturing images occurring in a flash, images in different image capturing boundaries can be captured to avoid missing any of the boundaries.

[0013] In one embodiment of this invention, the first image captured by the first lens module 120 is a portrait image (captured in a portrait mode), and the second image captured by the second lens module 130 is a landscape image (captured in a landscape mode). Hence, the disposed orientation of the first lens module 120 is substantially vertical to that of the second lens module 130. Therefore, the first image (portrait image) captured by the first lens module 120 may be substantially vertical to the second image (landscape image) captured by the second lens module 130. In other words, a portrait image and a landscape image can be captured at the same time without moving the handheld electrical device 100. In addition, when the user selects a video mode of a traditional handheld electrical device, the user can only take a landscape video. If the user wants to view the landscape video on a portrait screen, the user has to wait a long time for image trans-coding. In other words, during the trans-coding, the original coded landscape video must be decoded before encoding to a portrait video. Since the image trans-coding takes a long time, the user can't view the landscape images immediately. Besides, since the landscape images are coded twice, the landscape images may be distorted, which may lead to worse image quality. If the present invention is applied, the user can switch between portrait images and landscape images without too much image distortion.

[0014] Besides, the handheld electrical device 100 can display image captured by different lens modules with different image capturing boundaries corresponding to the orientation (such as portrait orientation or landscape orientation) of the handheld electrical device 100. Hence, the handheld electrical device 100 may further include a display unit 150 and an orientation sensing module 160. The orientation sensing module 160 is configured to sense an orientation of the handheld electrical device. Wherein, the orientation sensing module 160 may be a g sensor or any other element which can sense the orientation of the handheld electrical device 100. Hence, when the handheld electrical device 100 is in a photograph mode, the handheld electrical device 100 can control the display unit 150 to display images captured by different lens modules with different image capturing boundaries corresponding to the orientation of the handheld electrical device 100. Wherein, when the orientation sensing module 160 senses that the handheld electrical device 100 is in a first orientation, the control unit 110 controls the display unit 150 to display a scene captured by the first lens module 120 with the first image capturing boundary; when the orientation sensing module 160 senses that the handheld electrical device 100 is in a second orientation, the control unit 110 controls the display unit 150 to display another scene captured by the second lens module 130 with the second image capturing boundary. Wherein, the first orientation and the second orientation are different. Hence, when the handheld electrical device 100 is in the photograph mode, the handheld electrical device 100 can control its display unit 150 to display scenes captured by different lens modules with different image capturing boundaries in real time corresponding to the orientation of the handheld electrical device 100. In other words, when the handheld electrical device 100 is in the photograph mode, the user can change the orientation of the handheld electrical device 100 to control the handheld electrical device 100 to display scenes captured with different image capturing boundaries.

[0015] Fig. 3 illustrates a front-view diagram of the handheld electrical device in Fig. 1 in a portrait orientation. Fig. 4 illustrates a front-view diagram of the handheld electrical device in Fig. 1 in a landscape orientation. In one embodiment of this invention, the first orientation of the handheld electrical device 100 may be a portrait orientation, and the second orientation of the handheld electrical device 100 may be a landscape orientation. Hence, when the orientation sensing module 160 senses that the handheld electrical device 100 is in the portrait orientation, the control unit 110 controls the display unit 150 to display the portrait image captured by the first lens module 120 with the first image capturing boundary (as shown in Fig. 3). When the orientation sensing module 160 senses that the handheld electrical device 100 is in the landscape orientation, the control unit 110 controls the display unit 150 to display the landscape image captured by the second lens module 130 with the second image capturing boundary (as shown in Fig. 4). In other embodiments, the first orientation and the second orientation are not limited to the portrait orientation and the landscape orientation in this disclosure. Therefore, when the handheld electrical device 100 is in the photograph mode, the user can put the handheld electrical device 100 in the portrait or landscape orientation to display the portrait or landscape image correspondingly for user's convenience. Besides, the portrait image being displayed horizontally or the landscape image being displayed vertically on the display unit 150, which may waste the display area of the display unit 150, can be avoided.

[0016] When the handheld electrical device 100 displays images captured by one of the lens modules, at least one indication line to indicate the boundary of the other lens module can be displayed on the displayed images. Hence, when the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the handheld electrical device 100 is in the first orientation, the control unit 110 controls the display unit 150 to display a scene captured by the first lens module 120 with the first image capturing boundary, and to further display one or more first indication lines on the displayed scenes. Wherein the one or more first indication lines indicate the position that the second image capturing boundary captured by the second lens module 130 corresponds to the first image capturing boundary. In one embodiment of this invention, the first indication line may be a fixed position on the displayed first image capturing boundary. In another embodiment of this invention, the position of the first indication line can be obtained by comparing the scenes captured with the first image capturing boundary with that with the second image capturing boundary. However, the corresponding position of the first indication line can be obtained utilizing other methods, which should not be limited in this disclosure.

[0017] Besides, when the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the orientation of the handheld electrical device 100 is in the second orientation, the control unit 110 controls the display unit 150 to display a scene captured by the second lens module 130 with the second image capturing boundary, and to further display one or more second indication lines on the displayed scenes to indicate the first image capturing boundary captured by the first lens module 120. Therefore, when the handheld electrical device 100 displays images captured by one of the lens modules, at least one indication line to indicate the boundary of the other lens module can be displayed on the displayed images, which can help users understand the boundary captured by the other lens module.

[0018] Fig. 5 illustrates an embodiment of the indication line displayed on the handheld electrical device 100 in Fig. 1. Fig. 6 illustrates another embodiment of the indication line displayed on the handheld electrical device 100 in Fig. 1. For example, the first orientation of the handheld electrical device 100 may be a portrait orientation, and the second orientation of the handheld electrical device 100 may be a landscape orientation. Hence, when the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the handheld electrical device 100 is in the portrait orientation, the control unit 110 controls the display unit 150 to display the portrait image 201 captured by the first lens module 120 with the first image capturing boundary, and to further display a first indication line 201 a (as shown in Fig. 5) on the displayed first image 201. Wherein the first indication line 201 a indicate the position that the second image capturing boundary captured by the second lens module 130 corresponds to the first image capturing boundary. Besides, when the orientation sensing module 160 senses that the handheld electrical device 100 is in the landscape orientation, the control unit 110 controls the display unit 150 to display the landscape image 202 captured by the second lens module 130 with the second image capturing boundary, and to further display one second indication line 202a on the displayed scenes (as shown in Fig. 6) to indicate the first image capturing boundary captured by the first lens module 120. Therefore, when photographing portrait images, the corresponding landscape images can be indicated; when photographing landscape images, the corresponding portrait images can be indicated, which can assist users during photographing. In other embodiments, more indication lines can be further displayed, which should not be limited in this disclosure.

[0019] When the handheld electrical device 100 displays images captured by one of the lens modules, a miniature captured by the other lens module can be further displayed. Hence, when the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the handheld electrical device is in the first orientation, the control unit 110 controls the display unit 150 to further display a first miniature captured with the second image capturing boundary. When the handheld electrical device 100 is in the photograph mode and the orientation sensing module senses that the handheld electrical device 100 is in the second orientation, the control unit 110 controls the display unit 150 to further display a second miniature captured with the first image capturing boundary. Therefore, when the handheld electrical device 100 displays images captured by one of the lens modules, users can reach the miniature captured by the other lens module with the other image capturing boundary.

[0020] Fig. 7 illustrates an embodiment of the miniature displayed on the handheld electrical device 100 in Fig. 1. Fig. 8 illustrates another embodiment of the miniature displayed on the handheld electrical device 100 in Fig. 1. For example, the first orientation of the handheld electrical device 100 may be a portrait orientation, and the second orientation of the handheld electrical device 100 may be a landscape orientation. Hence, when the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the handheld electrical device is in the portrait orientation, the control unit 110 controls the display unit 150 to display the portrait image 301 captured by the first lens module 120 with the first image capturing boundary, and to further display a first miniature 301 a of the landscape image captured with the second image capturing boundary (as shown in Fig. 7). When the handheld electrical device 100 is in the photograph mode and the orientation sensing module 160 senses that the handheld electrical device is in the landscape orientation, the control unit 110 controls the display unit 150 to display the landscape image 302 captured by the first lens module 130 with the second image capturing boundary, and to further display a second miniature 302a of the portrait image captured with the first image capturing boundary (as shown in Fig. 8).

[0021] When the handheld electrical device 100 is in a browsing mode, the handheld electrical device 100 can display images corresponding to its orientation. Hence, when the handheld electrical device 100 is in a browsing mode and the orientation sensing module 160 senses that the handheld electrical device 100 is in the first orientation, the control unit 110 controls the display unit 150 to display the first image. When the handheld electrical device 100 is in the browsing mode and the orientation sensing module 160 senses that the handheld electrical device 100 is in the second orientation, the control unit 110 controls the display unit 150 to display the second image. Hence, when the handheld electrical device 100 is in the browsing mode, the handheld electrical device 100 can control its display unit 150 to display images captured with different image capturing boundaries corresponding to the orientation of the handheld electrical device 100. In other words, when the handheld electrical device 100 is in the browsing mode, the user can change the orientation of the handheld electrical device 100 to control the handheld electrical device 100 to display images captured with different image capturing boundaries for browsing, which is convenient to users for operation.

[0022] In addition, the handheld electrical device 100 can set the first image capturing boundary and the second image capturing boundary according to the interesting characteristics set by the user. Hence, the control unit 110 can receive an interesting characteristic through the input unit 140. The control unit 110 determines the first image capturing boundary and the second image capturing boundary automatically according to the interesting characteristic. Then, the first lens module 120 can capture the first image with the interesting characteristic according to the first image capturing boundary; the second lens module 130 can capture the second image with the interesting characteristic according to the second image capturing boundary. Wherein, the interesting characteristic may be a human facial feature, smiling feature etc.. Therefore, the interesting characteristic, which interests user, can always captured in the image.

[0023] Fig. 9 is a flow diagram of a dual image capturing method according to one embodiment of this invention. In the dual image capturing method, when a user wants to utilize a handheld electrical device to capture images, the handheld electrical device controls different lens modules, image capturing boundaries of which are different, to capture images with the different image capturing boundaries at the same time. The dual image capturing method is suitable for a handheld electrical device. The handheld electrical device includes a first lens module with a first image capturing boundary and a second lens module with a second image capturing boundary. Wherein, the first image capturing boundary and the second image capturing boundary are different. The dual image capturing method can be implemented as a computer program product, which includes at least one program instruction. The at least one program instruction of the computer program product is used for being loaded into the handheld electrical device. After the at least one program instruction of the computer program product is loaded into the handheld electrical device, the handheld electrical device executes the steps of the dual image capturing method. The computer program product can be stored in a handheld-electrical-device readable storage medium. Any suitable storage medium may be used including nonvolatile memory such as read only memory (ROM), programmable read only memory (PROM), erasable programmable read only memory (EPROM), and electrically erasable programmable read only memory (EEPROM) devices; volatile memory such as SRAM, DRAM, and DDR-RAM; optical storage devices such as CD-ROMs and DVD-ROMs; and magnetic storage devices such as hard disk drives and floppy disk drives.

[0024] The dual image capturing method 400 includes the following steps:

[0025] In step 410, a user input for capturing images is received.

[0026] In step 420, when the user input is received (step 410), a first image and a second image are captured at the same time by the first lens module and the second lens module respectively. Wherein, the first image is the one captured by the first lens module with the first image capturing boundary, and the second image is the one captured by the second lens module with the second image capturing boundary. The first image and the second image may include pictures, videos or other types of image. Therefore, the handheld electrical device can capture images with different image capturing boundaries at the same time without moving the handheld electrical device.

[0027] In one embodiment of step 420, the first image, which is captured by the first lens module with the first image capturing boundary, may be a portrait image (captured in a portrait mode), and the second image, which is captured by the second lens module with the second image capturing boundary, may be a landscape image (captured in a landscape mode). Therefore, a portrait image and a landscape image can be captured at the same time without moving the handheld electrical device. In addition, when the user selects a video mode of a traditional handheld electrical device, the user can only take a landscape video. If the user wants to view the landscape video on a portrait screen, the user has to wait a long time for image trans-coding. In other words, during the trans-coding, the original coded landscape video must be decoded before encoding to a portrait video. Since the image trans-coding takes a long time, the user can't view the landscape images immediately. Besides, since the landscape images are coded twice, the landscape images may be distorted, which may lead to worse image quality. If the present invention is applied, the user can switch between portrait images and landscape images without too much image distortion.

[0028] Besides, the handheld electrical device can display image captured by different lens modules with different image capturing boundaries corresponding to the orientation (such as portrait orientation or landscape orientation) of the handheld electrical device. Hence, in step 430, an orientation of the handheld electrical device may be sensed. Wherein, the orientation of the handheld electrical device may be sensed (step 430) utilizing a g sensor or any other element which can do orientation sensing.

[0029] In step 440, when the handheld electrical device is in a first orientation and the handheld electrical device is in a photograph mode, the handheld electrical device displays a scene captured by the first lens module with the first image capturing boundary.

[0030] In step 450, when the handheld electrical device is in a second orientation and the handheld electrical device is in a photograph mode, the handheld electrical device displays another scene captured by the second lens module with the second image capturing boundary. Wherein, the first orientation and the second orientation are different. Hence, when the handheld electrical device is in the photograph mode, the handheld electrical device can display scenes captured by different lens modules with different image capturing boundaries in real time corresponding to the orientation of the handheld electrical device. Besides, the first orientation of the handheld electrical device may be a portrait orientation, the second orientation of the handheld electrical device may be a landscape orientation, the first image corresponding to the first orientation (portrait orientation) is a portrait image, and the second image corresponding to the second orientation (landscape orientation) is a landscape image. Therefore, when the handheld electrical device is in the photograph mode, the user can put the handheld electrical device in the portrait or landscape orientation correspondingly for user's convenience. Besides, the portrait image being displayed horizontally or the landscape image being displayed vertically on the display unit of the handheld electrical device, which may waste the display area of the handheld electrical device, can be avoided.

[0031] When the handheld electrical device displays images captured by one of the lens modules, at least one indication line to indicate the boundary of the other lens module can be displayed on the displayed images. Hence, when the handheld electrical device is in the photograph mode and the handheld electrical device is in the first orientation, the handheld electrical device can further display one or more first indication lines on the displayed scenes on the displayed images in step 440. Wherein the one or more first indication lines indicate the position that the second image capturing boundary captured by the second lens module corresponds to the first image capturing boundary. Besides, when the handheld electrical device is in the photograph mode and the handheld electrical device is in the second orientation, the handheld electrical device further displays one or more second indication lines on the displayed images in step 450. Wherein the one or more second indication lines indicate the position that the first image capturing boundary captured by the first lens module corresponds to the second image capturing boundary. Therefore, when the handheld electrical device displays images captured by one of the lens modules, at least one indication line to indicate the corresponding boundary of the other lens module can be displayed on the displayed images, which can help users understand the boundary captured by the other lens module.

[0032] When the handheld electrical device displays images captured by one of the lens modules, a miniature captured by the other lens module can be further displayed. Hence, when the handheld electrical device is in the photograph mode and the handheld electrical device is in the first orientation, the handheld electrical device may further display a first miniature captured with the second image capturing boundary on the images displayed in step 440. When the handheld electrical device is in the photograph mode and the handheld electrical device is in the second orientation, the handheld electrical device may further display a second miniature captured with the first image capturing boundary on the images displayed in step 450. Therefore, when the handheld electrical device displays images captured by one of the lens modules, users can reach the miniature captured by the other lens module in the other image capturing boundary.

[0033] When the handheld electrical device is in a browsing mode, the handheld electrical device can display images corresponding to its orientation. Hence, when the handheld electrical device is in the first orientation and the handheld electrical device is in the browsing mode, the handheld electrical device displays the first image captured by the first lens module. Besides, when the handheld electrical device is in the second orientation and the handheld electrical device is in the browsing mode, the handheld electrical device displays the second image captured by the second lens module. Hence, when the handheld electrical device is in the browsing mode, the handheld electrical device can display images captured with different image capturing boundaries corresponding to the orientation of the handheld electrical device.

[0034] In addition, the handheld electrical device can set the first image capturing boundary and the second image capturing boundary, which are taken as the factor to execute step 420, according to the interesting characteristics set by the user. Hence, the dual image capturing method 400 may further includes the following steps: an interesting characteristic is received. The first image capturing boundary and the second image capturing boundary are determined automatically according to the interesting characteristic, such that the image with the interesting characteristic can be captured. Wherein, the interesting characteristic may be a human facial feature, smiling feature etc.. Hence, in step 420, the first image and the second image are captured at the same time by the first lens module and the second lens module according to the first image capturing boundary and the second image capturing boundary respectively. Therefore, the interesting characteristic, which interests user, can always captured in the image.

[0035] Above all, the handheld electrical device can capture images with different image capturing boundaries at the same time without moving the handheld electrical device. Hence, when capturing images occurring in a flash, images in different image capturing boundaries can be captured to avoid missing any of the boundaries. Besides, if the images captured by the handheld electrical device are videos, the user can switch between portrait images and landscape images without too much image distortion.

[0036] Although the present invention has been described in considerable detail with reference to certain embodiments thereof, other embodiments are possible. Therefore, the spirit and scope of the appended claims should not be limited to the description of the embodiments contained herein. It will be apparent to those skilled in the art that various modifications and variations can be made to the structure of the present invention without departing from the scope or spirit of the invention. In view of the foregoing, it is intended that the present invention cover modifications and variations of this invention provided they fall within the scope of the following claims.

Claims

1. A handheld electrical device comprising:

    a first lens module with a first image capturing boundary, disposed on the handheld electrical device ;
    a second lens module with a second image capturing boundary, disposed on the handheld electrical device, wherewith the first image capturing boundary and the second image capturing boundary are different;
    an input unit, configured to receive a user input for capturing images; and
    a control unit, configured to control the first lens module and the second lens module to respectively capture a first image and a second image at the same time when the input unit receives the user input.

2. The handheld electrical device of claim 1, wherein the first image is a portrait image, the second image is a landscape image, and the disposed orientation of the first lens module is substantially vertical to that of the second lens module.

3. The handheld electrical device of claim 1 further comprising:

    a display unit;
    an orientation sensing module, configured to sense an orientation of the handheld electrical device; and
    wherein when the handheld electrical device is in a photograph mode:

        when the orientation sensing module senses that the handheld electrical device is in a first orientation, the control unit controls the display unit to display a scene captured by the first lens module with the first image capturing boundary; and

when the orientation sensing module senses that the handheld electrical device is in a second orientation, the control unit controls the display unit to display another scene captured by the second lens module with the second image capturing boundary.

4. The handheld electrical device of claim 3, wherein:

when the handheld electrical device is in the photograph mode and the orientation sensing module senses that the handheld electrical device is in the first orientation, the control unit controls the display unit to further display one or more first indication lines to indicate the second image capturing boundary; and

when the handheld electrical device is in the photograph mode and the orientation sensing module senses that the handheld electrical device is in the second orientation, the control unit controls the display unit to further display one or more second indication lines to indicate the first image capturing boundary.

5. The handheld electrical device of claim 3, wherein:

when the handheld electrical device is in the photograph mode and the orientation sensing module senses that the handheld electrical device is in the first orientation, the control unit controls the display unit to further display a first miniature captured by the second lens module with the second image capturing boundary; and

when the handheld electrical device is in the photograph mode and the orientation sensing module senses that the handheld electrical device is in the second orientation, the control unit controls the display unit to further display a second miniature captured by the first lens module with the first image capturing boundary.

6. The handheld electrical device of claim 1 further comprising:

when the handheld electrical device is in a browsing mode and a orientation sensing module of the handheld electrical device senses that the handheld electrical device is in a first orientation, the control unit controls a display unit of the handheld electrical device to display the first image; and

when the handheld electrical device is in the browsing mode and the orientation sensing module senses that the handheld electrical device is in a second orientation, the control unit controls the display unit to display the second image.

7. The handheld electrical device of claim 1, wherein the first image and the second image include pictures and/or videos.

8. A dual image capturing method for a handheld electrical device, wherein the handheld electrical device comprises a first lens module with a first image capturing boundary and a second lens module with a second image capturing boundary, wherewith the first image capturing boundary is different from the second image capturing boundary, the method comprises:

receiving a user input for capturing images; and

capturing a first image and a second image at the same time by the first lens module and the second lens module respectively when the user input is received.

9. The method of claim 8, wherein the first image is a portrait image, and the second image is a landscape image.

10. The method of claim 8 further comprising:

sensing an orientation of the handheld electrical device; and

when the handheld electrical device is in a photograph mode:

when handheld electrical device is in a first orientation, making the handheld electrical device display a scene captured by the first lens module with the first image capturing boundary; and

when the handheld electrical device is in a second orientation, making the handheld electrical device display another scene captured by the second lens module with the second image capturing boundary.

11. The method of claim 10 further comprising:

when the handheld electrical device is in the photograph mode and the handheld electrical device is in the first orientation, further displaying one or more first indication lines to indicate the second image capturing boundary; and

when the handheld electrical device is in the photograph mode and the handheld electrical device is in the second orientation, further displaying one or more second indication lines to indicate the first image capturing boundary.

12. The method of claim 10 further comprising:

when the handheld electrical device is in the photograph mode and the handheld electrical device is in the first orientation, further displaying a first miniature captured by the second lens module with the second image capturing boundary; and

when the handheld electrical device is in the photograph mode and the handheld electrical device is in the second orientation, further displaying a second miniature captured by the first lens module with the first image capturing boundary.

13. The method of claim 8 further comprising:

when the handheld electrical device is in a browsing mode and the handheld electrical device is in a first orientation, displaying the first image; and

when the handheld electrical device is in the browsing mode and the handheld electrical device is in a second orientation, displaying the second image.

14. The method of claim 8, wherein the first image and the second image include pictures and/or videos.

15. A computer program product comprising at least one program instruction for being loaded into a handheld electrical device, wherein the handheld electrical device comprises a first lens module with a first image capturing boundary and a second lens module with a second image capturing boundary, wherewith the first image capturing boundary is different from the second image capturing boundary, wherein the at least one program instruction executes at least following steps after loading into the handheld electrical device:

receiving a user input for capturing images; and

capturing a first image and a second image at the same time by the first lens module and the second lens module respectively when the user input is received.

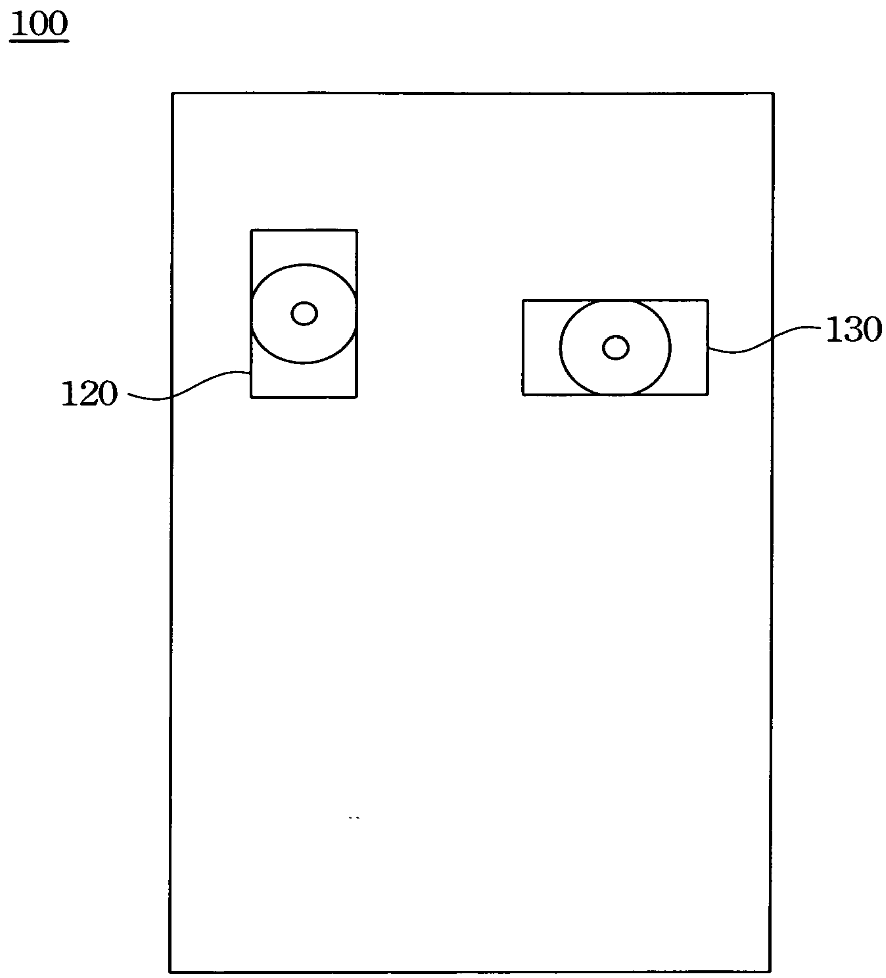

Fig. 1

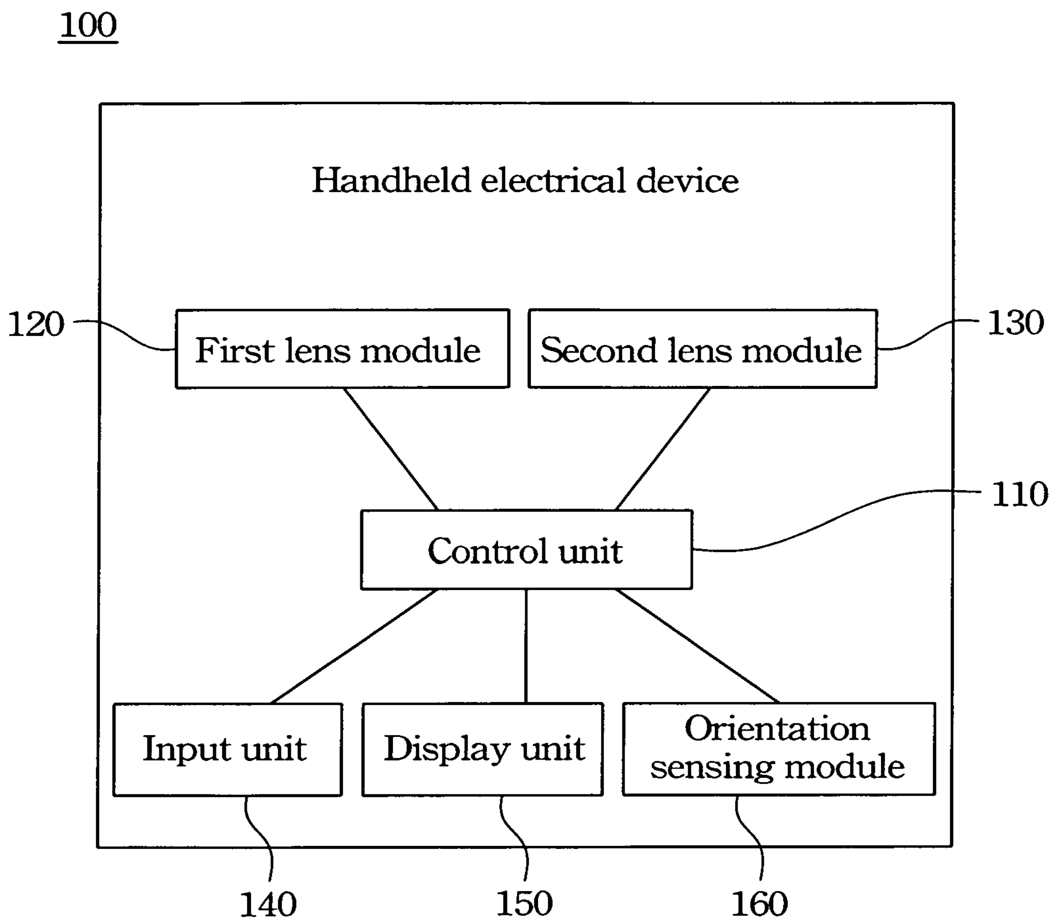
100
Handheld electrical device
120
First lens module
Second lens module
130
110
Control unit
Input unit
Display unit
Orientation sensing module
140
150
160

Fig. 2

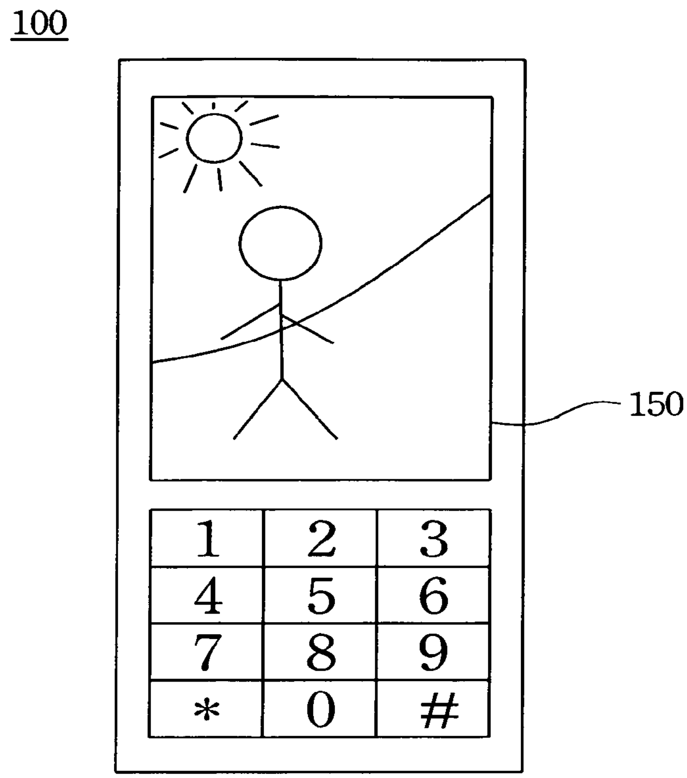

Fig. 3

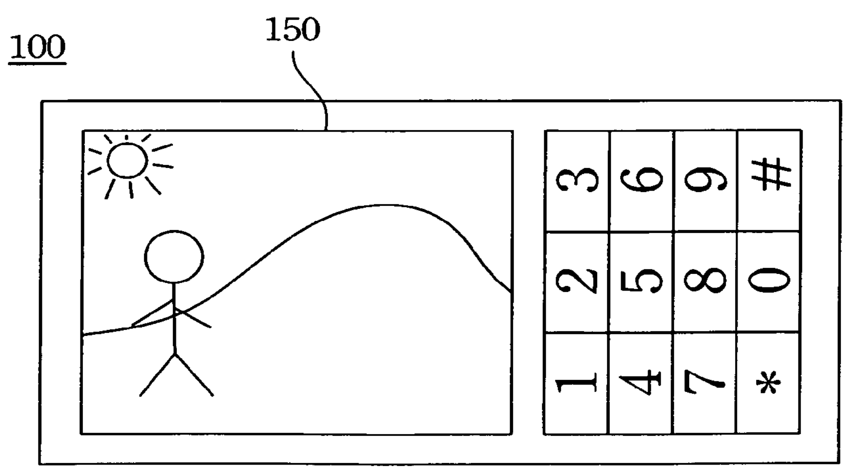

Fig. 4

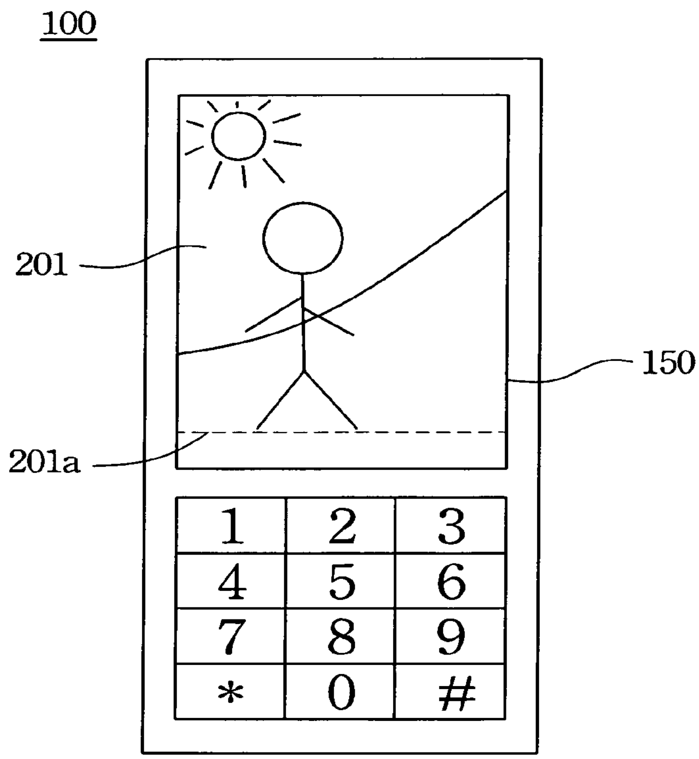

Fig. 5

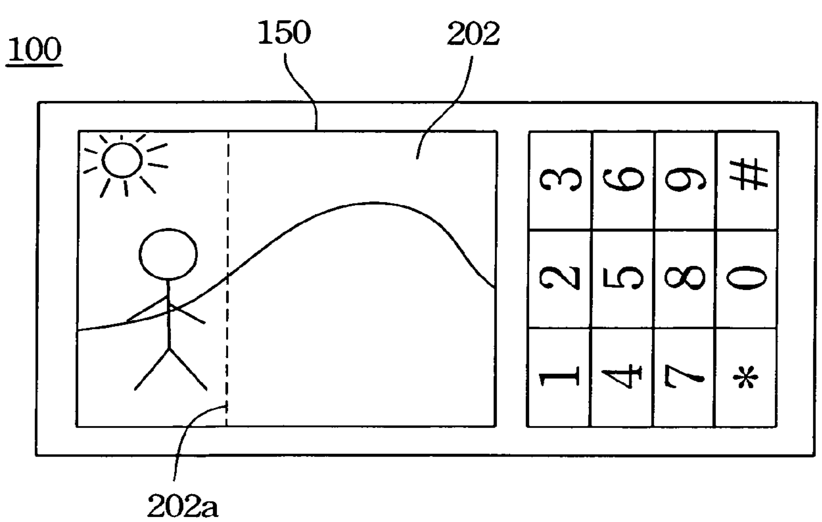

Fig. 6

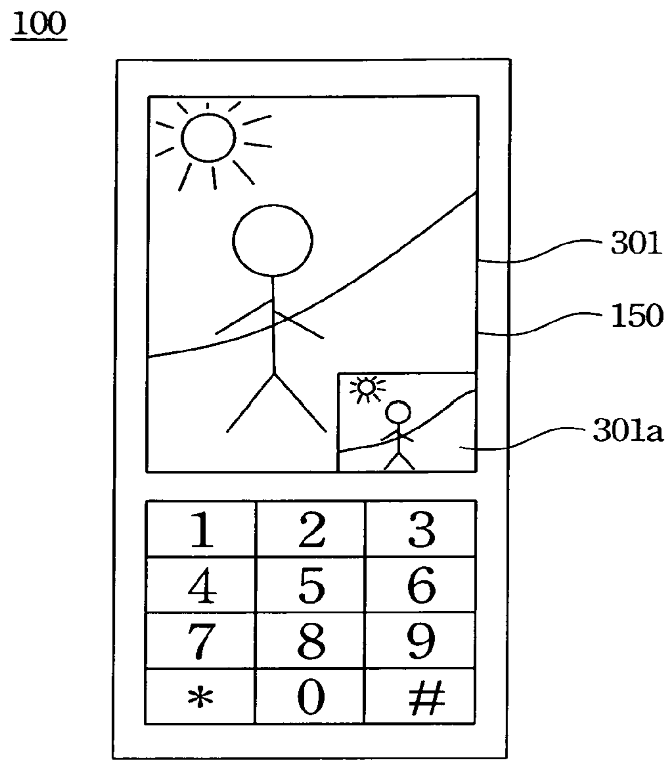

Fig. 7

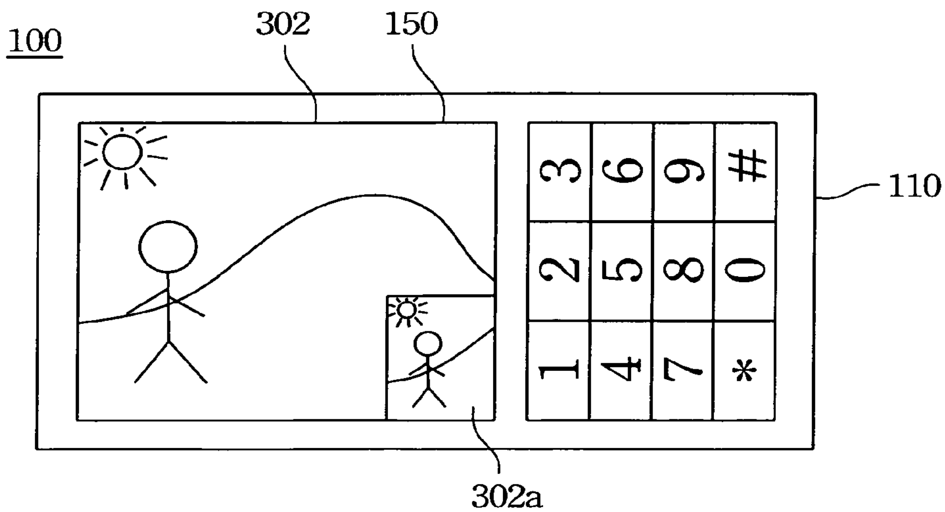

Fig. 8

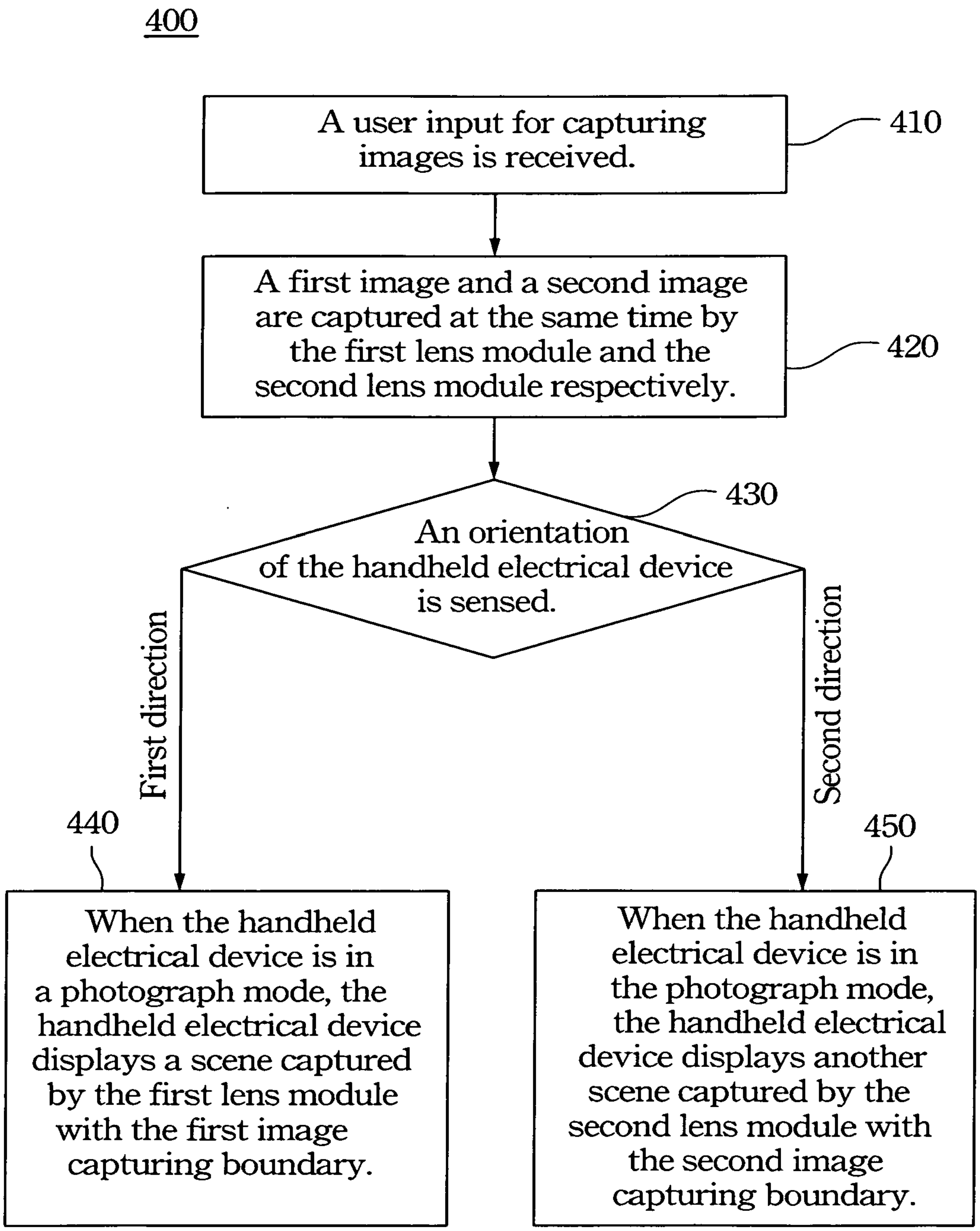
400
A user input for capturing images is received.
410
A first image and a second image are captured at the same time by the first lens module and the second lens module respectively.
420
An orientation of the handheld electrical device is sensed.
430
First direction
Second direction
440
450
When the handheld electrical device is in a photograph mode, the handheld electrical device displays a scene captured by the first lens module with the first image capturing boundary.
When the handheld electrical device is in the photograph mode, the handheld electrical device displays another scene captured by the second lens module with the second image capturing boundary.

Fig. 9

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EUROPEAN SEARCH REPORT

Application Number
EP 11 16 5407

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	US 2011/045812 A1 (KIM HO-SOO [KR] ET AL) 24 February 2011 (2011-02-24) * abstract; claims 11,21; figures 26-31 * * paragraphs [0007], [0011], [0148] - paragraph [0165] *	3-6, 10-13	
X Y	EP 1 763 243 A2 (LG ELECTRONICS INC [KR]) 14 March 2007 (2007-03-14) * abstract; figures 3,11, 14 * * paragraph [0037] - paragraph [0043] *	1,7,8, 14,15 3-6, 10-13	
X Y	EP 1 560 421 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP] PANASONIC CORP [JP]) 3 August 2005 (2005-08-03) * abstract; figures 2-4 *	1,7,8, 14,15 3-6, 10-13	TECHNICAL FIELDS SEARCHED (IPC)
X Y	WO 01/31893 A1 (NOKIA MOBILE PHONES LTD [FI]; HAERMAE ESA [FI]) 3 May 2001 (2001-05-03) * abstract; figure 2 *	1,7,8, 14,15 3-6, 10-13	H04N H04M G06F
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	8 August 2011	Katruff, Martin

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
& : member of the same patent family, corresponding document

3

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 11 16 5407

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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08-08-2011

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US 2010238327 A1	23-09-2010	WO 2010108119 A2	23-09-2010

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

Apparatus and method for realizing multi-resolutions image acquisition with multi-focusing video camera

Abstract

A device and a method for using a multi-focusing camera to realize collection of multi-resolution images are disclosed, comprising five focusing cameras having restraining relationship with others, wherein four of them are located at the same horizontal plane and on four top points of the same square, and the four cameras have the identical focus which is set as f<s>; the rest 1 camera is located in the direction of the four cameras, axes line of the camera is perpendicular to the surfaces of four cameras and passes a central point O of the square, and the distance from the fifth camera to the rest four cameras is d, the focus of the camera is set as f<t>, and initial setting is performed to the parameters and locations of the five focusing cameras with the location relationship satisfying the following restraint: f<t>=f<s>+d. The invention achieves the function of lossless zooming film of the multi-focusing camera with adjustable details of scenes and images, and with flexible and controllable structure, the invention can rapidly collect the multi-resolution images in the large visual scene.

CN101276415A

CN Application

Other languages: Chinese

Inventor: Wei Wu, Zhong Zhou, Zhang Shujun, Xu Zhao, Zhao Yuping

Original Assignee: Beijing Aerospace University

Priority date : 2008-03-03

Family: CN (1)

Date	App/Pub Number	Status
2008-03-03	CN 200810101241	
2008-10-01	CN101276415A	Application

Abstract

PROBLEM TO BE SOLVED: To provide a thin camera module that can selectively obtain images of different magnifications, and is suitable to portable equipment.

SOLUTION: The camera module comprises a plurality of lens units 21, 22 having different focal lengths, image sensor chips 25a and 25b which process imaging signals based upon light made incident through the lens units, and a selecting means of selecting the light made incident through the plurality of lens units and imaging signals based upon the light. This selecting means is operative to select light made incident through one of the plurality of lens units or an imaging signal based upon the light.

JP2007306282A

JP Application

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Other languages: Japanese

Inventor: Yasuaki Kayanuma, Anzhao

Original Assignee: Citizen Electronics Co Ltd, Citizen Electronics Co., Ltd.

Priority date : 2006-05-11

Family: JP (1)

Date	App/Pub Number	Status
2006-05-11	JP2006132321A	Pending
2007-11-22	JP2007306282A	Application

Digital camera

Abstract

PROBLEM TO BE SOLVED: To provide a digital camera provided with a plurality of photographing optical systems and imaging elements for realizing high magnification zooming without interruption and upsizing.
SOLUTION: The digital camera has two kinds of modes comprising: a high image quality mode for processing an image obtained by composing high quality image information with a small field angle and possible for optical zooming obtained by a combination of a first CCD 30 with a small size and high pixel density, a first imaging lens 12 with a short focal length, a second CCD 32 with a large size and low pixel density, and a second imaging lens 14 with a long focal length and slightly lower quality image information with a large field angle by an image interpolation means; and a high magnification mode for processing an image obtained by composing high quality image information with a minimum field angle obtained by a combination of the first CCD 30 and the second imaging lens 14, and the second CCD 32 and the first imaging lens 12 and low quality image information with a large field angle by the image interpolation means 38. Each mode can be selected by selecting an optical path from each lens to each CCD to change the combination of the lenses and the CCDs.

JP2003298920A
JP Application

Find Prior Art Similar

Other languages: Japanese

Inventor: Mitsufumi Misawa, Michitaka Nakazawa, 光史 三沢, 道隆 中沢

Original Assignee: Fuji Photo Film Co Ltd, 富士写真フイルム株式会社

Priority date : 2002-03-29

Family: JP (1)

Date	App/Pub Number	Status
2002-03-29	JP2002096977A	Pending
2003-10-17	JP2003298920A	Application

Info: Cited by (23), Similar documents, Priority and Related Applications

External links: Espacenet, Global Dossier, Discuss

Camera system

Abstract

<P>PROBLEM TO BE SOLVED: To provide a camera system which makes a display image legible when a control of PTZ or the like is performed while an image of a Tele camera is seen by a display device, and which makes a display image legible in a recorded image in a camera system with a Tele/Wide camera. <P>SOLUTION: A camera system has a Tele camera means which enables a high-powered zoom by which a narrow range is photographed with a subject centered, a Wide camera means which enables a wide-angle shot by which a wide range is photographed including an adjacent area of a subject. The camera system is provided with a means for performing a PTZ (pan, tilt and zoom) control to a Tele camera, a means for communicating between the Tele camera and a Wide camera, a means for cutting an image complying with the PTZ control of the Tele camera from a Wide image, a means for magnifying the image cut from the Wide image to a Tele image, and a means for switching the Tele image with the Wide image to be transmitted. An image while the Tele camera is moving is substituted for an image by the Wide camera. <P>COPYRIGHT: (C)2006,JPO&NCIPI

JP2006238325A

JP Application

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Other languages: Japanese

Inventor: Keisuke Kagiwada, 啓介 鍵和田

Original Assignee: Canon Inc., キヤノン株式会社

Priority date : 2005-02-28

Family: JP (1)

Date	App/Pub Number	Status
2005-02-28	JP2005053348A	Withdrawn
2006-09-07	JP2006238325A	Application

Info: Cited by (6), Legal events, Similar documents, Priority and Related Applications

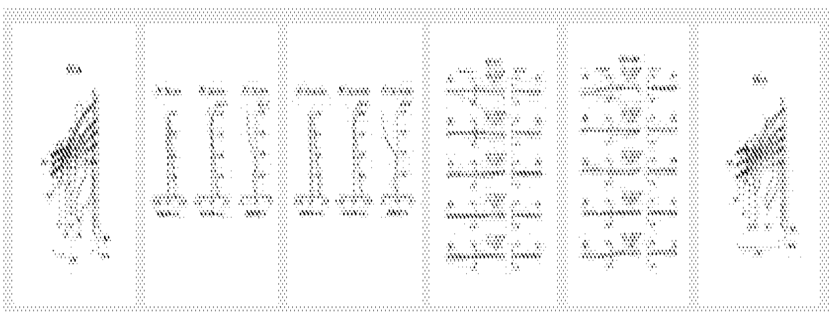
External links: Espacenet, Global Dossier, Discuss

Imaging apparatus

Abstract

PROBLEM TO BE SOLVED: To provide high image quality with high resolution for an entire wide variable power region.SOLUTION: An imaging apparatus includes first and second imaging optical systems LN1 and LN2 with single focus, which look the same direction. A focal length of the second imaging optical system LN2 is longer than that of the first imaging optical system LN1. Zooming is performed from a wide angle end to an intermediate focal length state with an electronic zoom by segmentation of an image obtained in the first imaging optical system LN1, and zooming is performed from the intermediate focal length state to a telescopic end with an electronic zoom by segmentation of an image obtained in the second imaging optical system. Thus, zooming from the wide angle end to the telescopic end is performed as a whole. Both the first and second imaging optical systems LN1 and LN2 consist of four or more lenses of first lenses of positive power and second lenses of negative power in order from an object side, the lenses nearest to the image side are negative lenses, composite focal lengths of the first lenses and the second lenses are positive and they satisfy a conditional expression :1.0<fFw/fFm<1.5.

Images (23)



JP2013106289A

JP Application

Other languages: Japanese

Inventor: Kenji Konno, 賢治 金野, Keiji Matsuzaka, 慶二 松坂, Keiko Yamada, 恵子 山田

Original Assignee: Konica Minolta Advanced Layers Inc, コニカミノルタアドバンストレイヤー株式会社

Priority date : 2011-11-16

Family: JP (1)

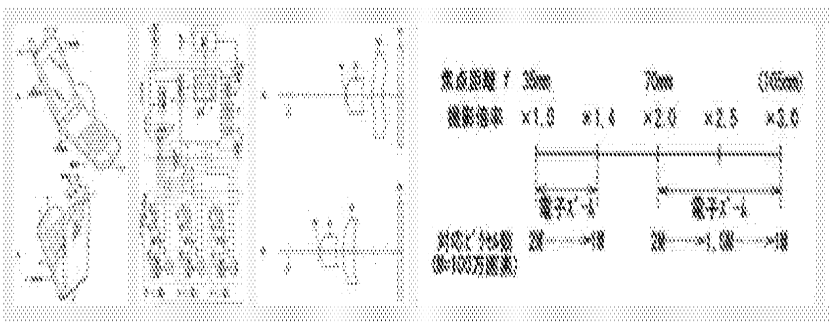
Date	App/Pub Number	Status
2011-11-16	JP2011250322A	Active
2013-05-30	JP2013106289A	Application
2015-07-01	JP5741395B2	Grant

Imaging apparatus, imaging method, and range finding method

Abstract

<P>PROBLEM TO BE SOLVED: To provide an imaging apparatus which realizes high precision range finding by utilizing a plurality of imaging systems having different photographic viewing angles and an imaging method and a range finding method, and to provide an imaging apparatus which realizes compensation of parallax caused among the plurality of imaging systems, with simple configuration, and an imaging method. <P>SOLUTION: Imaging signals from imaging systems 10A, 10B, and 10C are corrected so that photographed images by the respective imaging systems 10A, 10B, and 10C photographed at mutually different photographic viewing angles can be images photographed in the mutually same photographing conditions with respect to viewing angles, and correlation operations among photographic images by the imaging systems 10A, 10B, and 10C are performed on the basis of the respective corrected imaging signals, and a distance to an object is calculated on the basis of correlation values. Parallax correction is performed on the basis of information of the calculated distance. <P>COPYRIGHT: (C)2005,JPO&NCIPI

Images (18)



JP2005099265A

JP Application

Download PDF Find Prior Art Similar

Other languages: Japanese

Inventor: Yoshihiro Ito, Kenichi Sato, Hideo Yoshida, 嘉広 伊藤, 佐藤 賢一, 秀夫 吉田

Original Assignee: Fuji Photo Film Co Ltd, Fujinon Corp, フジノン株式会社, 富士写真フイルム株式会社

Priority date : 2003-09-24

Family: JP (1)

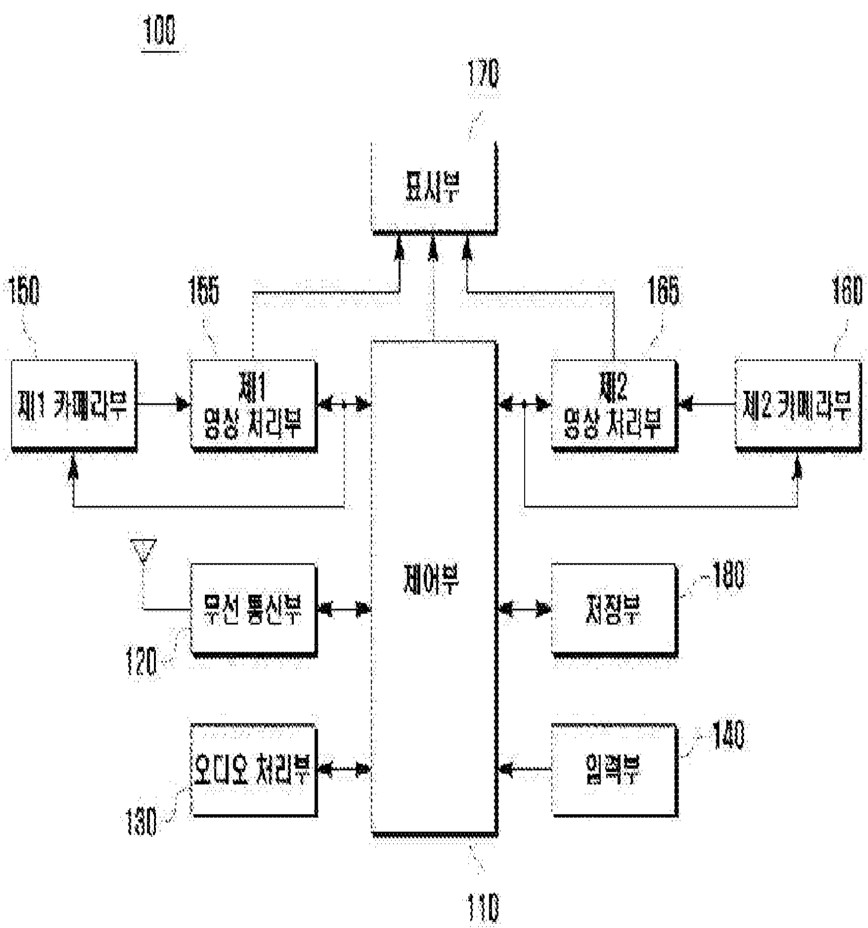
Date	App/Pub Number	Status
2003-09-24	JP2003331404A	Pending
2005-04-14	JP2005099265A	Application

Photographing method using a mobile terminal having a dual camera and this

Abstract

translated from Korean

The present invention relates to, and more particularly a portable terminal and a recording method using the same, recognizing the face of the photographer to take a picture and having a dual camera on the mobile terminal having a photographing function.
The present invention dual-in camera, a mobile terminal having a second camera portion, wherein the first the photographer of the image input via the camera part is a first camera unit, of the subject image is photographed person's image is input to be input recognizing the photographed to the subject to be imaged is characterized in that a control unit for controlling the second camera unit.
Because the recorded picture by recognizing the image of the photographer by using a dual-camera provided in the mobile terminal can acquire the right image to prevent camera shake, there is an advantage that the photographer can take an image of an object at the moment of intended.



KR101477178B1
KR Grant

Download PDF Find Prior Art Similar

Other languages: Korean

Inventor: friendship, Lee Byung-sun

Original Assignee: Samsung Electronics Co., Ltd.

Priority date : 2008-07-17

Family: KR (1)

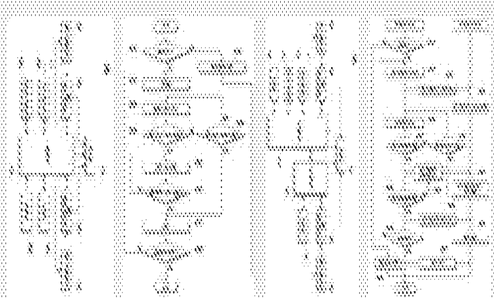
Date	App/Pub Number	Status
2008-07-17	KR20080069570A	
2010-01-27	KR20100008936A	Application
2014-12-29	KR101477178B1	Grant

Portable terminal having dual camera and photographing method using the same

Abstract

PURPOSE: A portable terminal with a dual camera and a photographing method using the same are provided to exactly and stably photograph at the time when a photographer intends regardless of the shake due to hand. CONSTITUTION: A first camera part(150) collects a first image. A second camera part(160) collects a second image. A controller(110) recognizes the first image inputted through the first camera part. The controller checks whether the recognized first image belongs to a preset reference image or not. According to the confirmation result, the controller controls the camera operation of the second camera part.

Images (4)



KR20100008936A

KR Application

Download PDF Find Prior Art Similar

Other languages: Korean

Inventor: friendship, Lee Byung-sun

Original Assignee: Samsung Electronics Co., Ltd.

Priority date : 2008-07-17

Family: KR (1)

Date	App/Pub Number	Status
2008-07-17	KR20080069570A	
2010-01-27	KR20100008936A	Application
2014-12-29	KR101477178B1	Grant

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 08271976
PUBLICATION DATE : 18-10-96

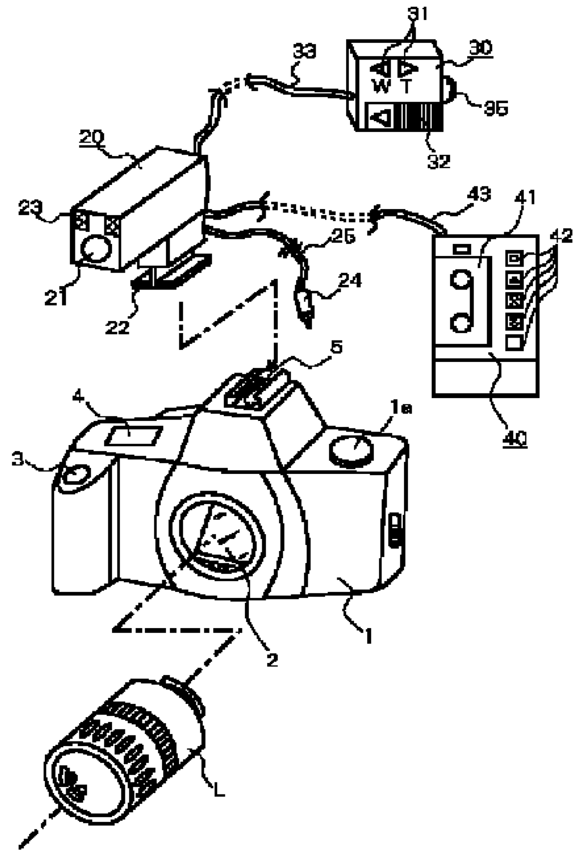
APPLICATION DATE : 29-03-95
APPLICATION NUMBER : 07094242

APPLICANT : CANON INC;

INVENTOR : TAMAMURA HIDEO;

INT.CL. : G03B 19/06 G03B 17/20 G03B 17/48 H04N 5/335

TITLE : CAMERA



ABSTRACT : PURPOSE: To enhance operability and quick photographing property by improving a finder function, in a camera provided with both video and still camera functions.

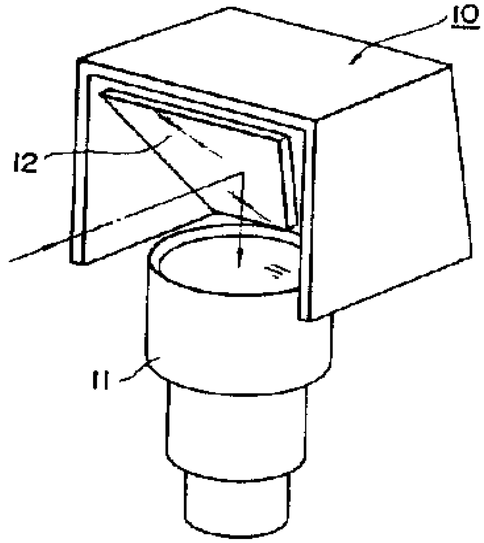
CONSTITUTION: The camera is constituted of a video camera part consisting of each of a video photographing camera unit 20, an operation unit 30 for changing a zoom ratio, driven by motor and a video deck part 40 recording video on a magnetic tape and a still camera part for exposing a sliver salt photographic film, to record a still picture. The video taken by the video camera part is displayed as a picture on an LCD in a camera main body 1 and a half mirror is disposed in mid-way of an optical path, so that when the picture is optically led to a part of a visual field in an optical finder, the picture of the video is placed in the still picture as a window. Further, a light shielding plate can be overlapped with or retreated from the rear surface of the half mirror, in accordance with the operation of a photographer.

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 04211230
PUBLICATION DATE : 03-08-92

APPLICATION DATE : 19-10-90
APPLICATION NUMBER : 02282755



APPLICANT : FUJI PHOTO FILM CO LTD;

INVENTOR : UEDA SATOSHI;

INT.CL. : G03B 5/00 G01P 9/00

TITLE : COMPENSATOR FOR CAMERA SHAKE BY HAND

ABSTRACT : PURPOSE: To realize the downsizing and cost reduction of a device by arranging a mirror to compensate camera shake caused by hand in front of a photographing lens, making possible design of the photographing lens without taking the mirror into consideration, and simplifying a mirror support mechanism.

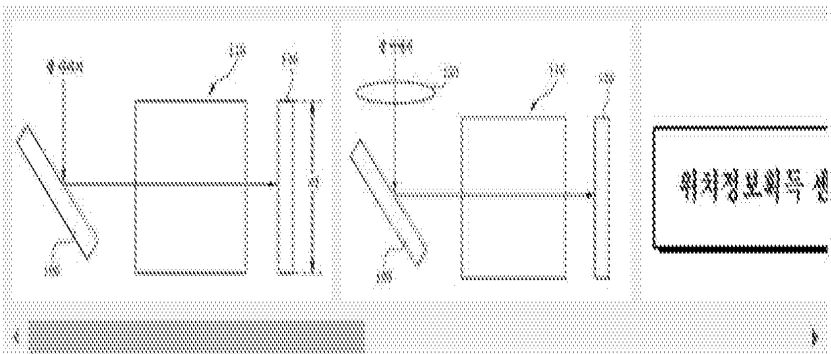
CONSTITUTION: A compensator 10 to compensate camera shake caused by hand is arranged in front of a photographing lens 11, and generally, introduces a subject image to the photographing lens 11 by folding down the image by 90 degrees by means of a mirror 12. The mirror 12 is tillably supported in all directions, and when a camera is put in tilting motion due to camera shake and the like, the mirror 12 is put in tilting motion by a half of the camera shake angle in the opposite direction to the camera shake direction, and thereby, image oscillation caused by camera shake and the like can be compensated.

Camera module

Abstract

The present invention relates to a camera module. According to an embodiment of the present invention, the camera module includes a reflector reflecting the optical image of an object; a lens; an actuator adjusting the focus of the optical image of the object; and an image sensor changing the optical image of the object to an electrical signal. [Reference numerals] (AA) Optical image

Images (5)



KR20140014787A

KR Application

Download PDF Find Prior Art Similar

Other languages: Korean

Inventor: Kim, Young-Ho

Original Assignee: LG Innotek Co., Ltd.

Priority date : 2012-07-26

Family: KR (1)

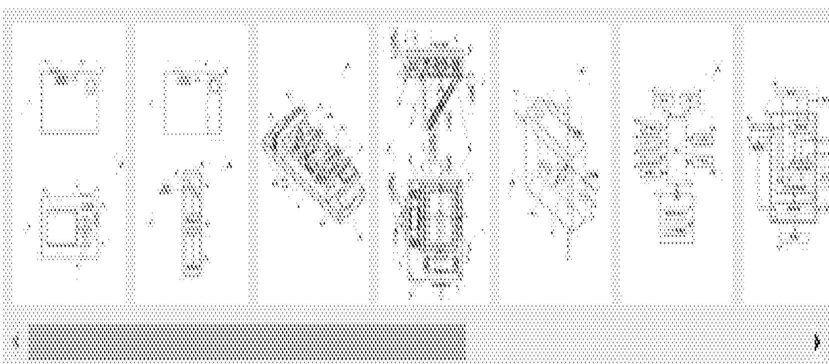
Date	App/Pub Number	Status
2012-07-26	KR20120081773A	
2014-02-06	KR20140014787A	Application

Digital camera

Abstract

<P>PROBLEM TO BE SOLVED: To provide a digital camera of a bent optical system for realizing pan/tilt photographing. <P>SOLUTION: A mirror 210 for bending incident light onto an imaging element is supported turnably around the X revolving axis and the Z revolving axis. A second actuator 321 is driven in response to a pan operation by a user to revolve the mirror 210 around the Z revolving axis. A first actuator 311 is driven in response to a tilt operation by the user to revolve the mirror 210 around the X revolving axis. Thus, the pan/tilt at moving picture photographing is achieved by the revolving of the mirror 210 in response to the user operation. That is, since the pan/tilt photographing can be executed in a state that a camera main body is at a standstill, a camera shake and an image shake caused by movement of the camera main body can be prevented.

Images (12)



JP2007228006A
JP Application

Download PDF   Find Prior Art   Similar

Other languages: Japanese

Inventor: Kazunori Kita, Ichigo

Original Assignee: Casio Comput Co Ltd, Casio Computer Co., Ltd.

Priority date : 2006-02-21

Family: JP (1)

Date	App/Pub Number	Status
2006-02-21	JP2006043435A	Expired - Fee Related
2007-09-06	JP2007228006A	Application
2011-02-02	JP4622882B2	Grant

Optical axis correcting mechanism

Abstract

PURPOSE: To prevent the generation of eroneous detection on the respective positions by correcting hand shake in the vertical direction by so-called an ABS system and in the horizontal direction by so-called a gimbal system.
CONSTITUTION: When hand shake in the vertical direction is generated, angle data detected by a hand shake amount arithmetic circuit 38V is compared with the position data of a correcting convex lens 5 obtained by a position sensor 18 in a position control circuit 39V for the correcting lens, the amount of angle to be corrected is detected, the correction data are outputted to a lens driving means 7, the correcting convex lens 5 is moved in the vertical direction and the optical axis is corrected. When hand shake in the horizontal direction is generated, the angle data are compared with the position data of a lens barrel 14 obtained by an angle position sensor 34, the amount of angle to be corrected is detected, the correction data are outputted to a barrel driving means 22, the lens barrel 14 is rotated in the horizontal direction and the optical axis is corrected.

JPH07318864A
JP Application

Find Prior Art   Similar

Other languages: Japanese

Inventor: Hiroshi Kawamura, Eiji Oshima, Kazuhiro Tanaka, Eiji Oshima, Yoshikawa, Wada and Tanaka

Original Assignee: Sony Corp, Sony Corporation

Priority date : 1994-05-20

Family: JP (1)

Date	App/Pub Number	Status
1994-05-20	JP12984994A	Expired - Fee Related
1995-12-08	JPH07318864A	Application
2002-12-09	JP3355787B2	Grant

Electronic Patent Application Fee Transmittal

Application Number:	15324720
Filing Date:	08-Jan-2017
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Filer:	Menachem Nathan
Attorney Docket Number:	COREPH-0159 US NP

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 1 month with $0 paid	2251	1	100	100
Miscellaneous:				
		Total in USD ($)		**100**

Electronic Acknowledgement Receipt

EFS ID:	33969934
Application Number:	15324720
International Application Number:	
Confirmation Number:	5811
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
Filer:	Menachem Nathan
Filer Authorized By:	
Attorney Docket Number:	COREPH-0159 US NP
Receipt Date:	10-OCT-2018
Filing Date:	08-JAN-2017
Time Stamp:	14:58:43
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$100
RAM confirmation Number	101118INTEFSW15031700
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	OA_Response.pdf	158030 df8e8524004aa939042369a115d6f1b05d5fe822	no	10
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30674 1fe18670172edfd97f97b43119a816c2446058df	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	188704		

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Applicant:	§	Confirmation No: 5811
	§	
Noy Cohen	§	
	§	
Serial No.: 15/324,720	§	
	§	
Filed: 01/08/2017	§	Group Art Unit: 2664
	§	
For: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL		
	§	Attorney Docket: Coreph-0159 US NP
	§	
Examiner: Tran, Nhan T.		

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

RESPONSE

Sir:

This is in response to the United States Patent and Trademark Office Action having a Notification Date of 06/19/2018, which response is being made with a one month extension for which the appropriate fee is paid herewith.

Amendment to the Specification is provided on page 2.

A listing and amendmens of Claims begins on page 3.

Remarks/Arguments begin on page 7.

IN THE DESCRIPTION:

Please amend the paragraph on page 12, lines 24-28 as follows:

Returning now to the Zoom-in process, in some embodiments, for higher ZF than the up-transfer ZF, the output is the transformed Tele camera output, digitally zoomed. However, in other embodiments, for higher ZF than the up-transfer ZF, there will be no switching from the Wide to the Tele camera output, i.e. the output will be from the Wide camera, digitally zoomed. This "no switching" process is described next.

IN THE CLAIMS:

Please amend the claims as follows:

1. (Currently amended) A zoom digital camera comprising:

a) a Wide imaging section that includes a fixed focal length Wide lens with a Wide field of view (FOV) and a Wide sensor, the Wide imaging section operative to provide Wide image data of an object or scene;

b) a Tele imaging section that includes a fixed focal length Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, the Tele imaging section operative to provide Tele image data of the object or scene; and

c) a camera controller operatively coupled to the Wide and Tele imaging sections~~, the camera controller~~ and configured to evaluate if a no-switching criterion is fulfilled or not fulfilled, ~~determined by inputs from both Wide and Tele image data,~~ ~~and,~~ wherein if the no-switching criterion is fulfilled in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value at a zoom factor (ZF) higher than an up-transfer ZF, the camera controller is further configured to output a zoom video output image that includes only Wide image data, and wherein if the no-switching criterion is not fulfilled, the camera controller is further configured to output a zoom video output image that includes only transformed, digitally zoomed Tele image data.

2. (Original) The camera of claim 1, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

3. (Original) The camera of claim 1, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

4. (Original) The camera of claim 1, wherein the no-switching criterion includes an

effective resolution of the Tele image being lower than an effective resolution of the Wide image.

5. (Original) The camera of claim 1, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

6. (Original) The camera of claim 1, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

7. (Original) The camera of claim 1, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third distance threshold.

8. (Original) The camera of claim 1, wherein the camera controller includes a user control module for receiving user inputs and a sensor control module for configuring each sensor to acquire the Wide and Tele image data based on the user inputs.

9. (Original) The camera of claim 8, wherein the user inputs include a zoom factor, a camera mode and a region of interest.

10. (Previously presented) The camera of claim 1, wherein the Tele lens includes a ratio of total track length (TTL)/effective focal length (EFL) smaller than 1.

11. (Cancelled)

12. (Previously presented) The camera of claim 1, wherein the camera controller is further configured to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a

particular point of view.

13. (Currently amended A method for obtaining zoom images of an object or scene using a digital camera, comprising the steps of:

a) providing in the digital camera a Wide imaging section having a Wide lens with a Wide field of view (FOV) and a Wide sensor, a Tele imaging section having a Tele lens with a Tele FOV that is narrower than the Wide FOV and a Tele sensor, and a camera controller operatively coupled to the Wide and Tele imaging sections; and

b) configuring the camera controller to evaluate if a no-switching criterion ~~determined by inputs from both Wide and Tele image data~~ is fulfilled or not fulfilled, and, if the no-switching criterion is fulfilled, configuring the camera controller to output at a zoom factor (ZF) higher than an up-transfer ZF a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ~~zoom factor (~~ZF~~)~~ value and a higher ZF value, or if the no-switching criterion is not fulfilled, configuring the camera controller to output a zoom video output image that includes only transformed, digitally zoomed Tele image data.

14. (Original) The method of claim 13, wherein the no-switching criterion includes a shift between the Wide and Tele images calculated by global registration, the shift being greater than a first threshold.

15. (Original) The method of claim 13, wherein the no-switching criterion includes a disparity range calculated by global registration, the disparity range being greater than a second threshold.

16. (Original) The method of claim 13, wherein the no-switching criterion includes an effective resolution of the Tele image being lower than an effective resolution of the Wide image.

17. (Original) The method of claim 13, wherein the no-switching criterion includes a number of corresponding features in the Wide and Tele images being smaller than a third threshold.

18. (Original) The method of claim 13, wherein the no-switching criterion includes a majority of objects imaged in an overlap area of the Wide and Tele images being calculated to be closer to the camera than a first threshold distance.

19. (Original) The method of claim 13, wherein the no-switching criterion includes some objects imaged in an overlap area of the Wide and Tele images being calculated to be closer than a second threshold distance while other objects imaged in the overlap area of the Wide and Tele images being calculated to be farther than a third threshold distance.

20. (Previously presented) The method of claim 13, further comprising the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image of the object or scene from a particular point of view.

21. (Previously presented) The method of claim 13, wherein the step of configuring the camera controller to combine in still mode, at a predefined range of ZF values, at least some of the Wide and Tele image data to provide a fused output image includes configuring the camera controller to combine Wide and Tele image data only in focused areas.

REMARKS

The present response is intended to be fully responsive to all points of objection and/or rejection raised by the Examiner and is believed to place the application in condition for allowance.

Applicant asserts that the instant invention is new, non-obvious and useful. Prompt consideration and allowance of the claims is respectfully requested.

Status of Claims

Claims 1-21 are pending in the application. Claims 1, 2, 8-11, 13, 14, 20 and 21 were rejected in the Office Action dated 06/19/2018. The rejection is respectfully traversed. Claims 3-7 and 15-19 were objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claim. The conditional allowance of claims 3-7 and 15-19 is gratefully acknowledged.

Claim 11 is cancelled herewith without prejudice, with most of its limitations being moved to claims 1 and 13. With the cancellation of claim 11, its rejection is moot.

Description and Claim amendments

Applicant hereby amends the language in the paragraph on page 12, lines 24-28 to add the inadvertently left out words "higher ZF than the" before "up-transfer ZF". These words should have clearly been present in view of the immediately previous sentence and in view of the qualifier "However" at the start of this sentence. No new matter is introduced.

Claims 1 and 13 are amended to recite the added limitation that if the no-switching criterion is fulfilled, the camera controller is configured to output at a zoom factor (ZF) higher than an up-transfer ZF a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF value and a higher ZF value, and if the no-switching criterion is not fulfilled, the camera controller is configured to output a zoom video output image that includes only transformed, digitally zoomed Tele image data. Support for the amendments may be found in p. 12, lines 24-28, in original claim 11, and in the broader description of the "zoom in" video operation at ZFs equal to or higher than the up-transfer ZF.

Claim rejections - 35 U.S.C. § 102

Claims 1, 2, 4, 8-14, 20 and 21 were rejected under 35 U.S.C. § 102(a)(1) as being anticipated by Shabtay et al. (WO 2014/199338, hereinafter Shabtay). The rejection is respectfully traversed. With the cancellation of claim 11, its rejection is moot. However, while traversing the rejection, Applicant hereby amends claim 1 to recite in (c):

c) a camera controller operatively coupled to the Wide and Tele imaging sections and configured to evaluate if a no-switching criterion is fulfilled or not fulfilled, wherein if the no-switching criterion is fulfilled in a zoom-in operation between a lower zoom factor (ZF) value and a higher ZF value at a zoom factor (ZF) higher than an up-transfer ZF, the camera controller is further configured to output a zoom video output image that includes only Wide image data, and wherein if the no-switching criterion is not fulfilled, the camera controller is further configured to output a zoom video output image that includes only transformed, digitally zoomed Tele image data.

and amends claim 13 to recite in (b):

b) configuring the camera controller to evaluate if a no-switching criterion is fulfilled or not fulfilled, and, if the no-switching criterion is fulfilled, configuring the camera controller to output at a zoom factor (ZF) higher than an up-transfer ZF a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF-value and a higher ZF value, or if the no-switching criterion is not fulfilled, configuring the camera controller to output a zoom video output image that includes only transformed, digitally zoomed Tele image data.

Support for the amendment may be found in p. 12, lines 24-28 as well as being clearly supported by the broader description of the "zoom in" video operation at ZFs equal to or higher than the up-transfer ZF.

Applicant respectfully submits that Shabtay does not teach in any way a camera controller configured to output, at a ZF higher than an up-transfer ZF, a zoom video output image that includes only Wide image data in a zoom-in operation between a lower ZF value and a higher ZF value. Shabtay teaches that at any ZF higher that the up-transfer ZF a camera outputs a Tele image. as indicated for example in Shabtay page 13, lines 10-14:

> Zoom-in: at low ZF up to slightly above ZFT, the output image is a digitally zoomed, Wide fusion output. *For the up-transfer ZF, the Tele image is shifted and corrected by global registration (GR) to achieve smooth transition. Then, the output is transformed to a Tele fusion output. For higher (than the up-transfer) ZF, the output is the Tele fusion output digitally zoomed.*

Applicant therefore submits that Shabtay cannot and does not anticipate claims 1, 13 and all claims depending therefrom, and cannot even render these claims unpatentable.

Claim objections

Claims 3-7 and 15-19 were objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claim. Applicant submits that with the amendment of claims 1 and 13 from which these claims depend directly or indirectly, these claims are allowable in their present form.

Conclusion

In view of the foregoing remarks, Applicant asserts that the pending claims are allowable. Their favorable reconsideration and allowance is respectfully requested.

Should the Examiner have any question or comment as to the form, content or entry of this Amendment, the Examiner is requested to contact the undersigned at the telephone number below. Similarly, if there are any further issues yet to be resolved to advance the prosecution of this application to issue, the Examiner is requested to telephone the undersigned counsel.

Respectfully submitted,

/Menachem Nathan/

Menachem Nathan
Agent for Applicant
Registration No. 65392

Tel: 516-442-9736

Date: October 10, 2018

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 15/324,720	Filing Date 01/08/2017	☐ To be Mailed

ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO

APPLICATION AS FILED – PART I

FOR	NUMBER FILED (Column 1)	NUMBER EXTRA (Column 2)	RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT

10/10/2018	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 20	Minus	** 21	= 0	x $50 =	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	x $230 =	0
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	**0**

AMENDMENT

	CLAIMS REMAINING AFTER AMENDMENT (Column 1)		HIGHEST NUMBER PREVIOUSLY PAID FOR (Column 2)	PRESENT EXTRA (Column 3)	RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))						
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))						
					TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

LIE
ROSA WEST

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

92342 7590 11/16/2018
Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

EXAMINER	
TRAN, NHAN T	
ART UNIT	**PAPER NUMBER**
2664	

DATE MAILED: 11/16/2018

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

TITLE OF INVENTION: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	02/19/2019

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

92342 7590 11/16/2018

Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

TITLE OF INVENTION: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	02/19/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
TRAN, NHAN T	2664	348-240990

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1____________________
2____________________
3____________________

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required) ❑Advance Order - # of Copies ____________

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. __________

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature ____________________ Date ____________________

Typed or printed name ____________________ Registration No. ____________________

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

92342 7590 11/16/2018

Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

EXAMINER	
TRAN, NHAN T	
ART UNIT	**PAPER NUMBER**
2664	

DATE MAILED: 11/16/2018

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	**Application No.** 15/324,720	**Applicant(s)** Cohen et al.	
	Examiner NHAN T TRAN	**Art Unit** 2664	**AIA Status** Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1.☑ This communication is responsive to amendment filed on 10/10/2018.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ______.

2.☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ______; the restriction requirement and election have been incorporated into this action.

3.☑ The allowed claim(s) is/are 1-10, 12-21 (renumbered as 1-20) . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4.☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ______ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file areply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5.☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ______ .

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6.☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1.☐ Notice of References Cited (PTO-892)
2.☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date ______.
3.☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material ______.
4.☐ Interview Summary (PTO-413), Paper No./Mail Date. ______.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other ______.

/NHAN T TRAN/
Primary Examiner, Art Unit 2664

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Arguments

2. Applicant's amendment and arguments, filed on 10/10/2018, with respect to claims 1-10 and 12-21 have been fully considered and are persuasive. The rejection indicated in the previous Office Action has been overcome and withdrawn.

Information Disclosure Statement

3. The information disclosure statement (IDS) submitted on 9/23/2018 is in compliance with the provisions of 37 CFR 1.97. Accordingly, the information disclosure statement is being considered by the examiner.

Specification

4. The amendment to the specification filed on 10/10/2018 is accepted and entered.

Allowable Subject Matter

5. Claims 1-10 and 12-21 are allowed.

6. The reasons for allowance of the claims are clear from the written record of prosecution. Attention is specifically drawn to the amendments and arguments dated 10/10/2018. As such, the reasons for allowance have been fully addressed and complied

according to MPEP 1302.14(I). As such, the reasons for allowance have been fully addressed and complied according to MPEP 1302.14(I).

Conclusion

7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to NHAN T TRAN whose telephone number is (571)272-7371. The examiner can normally be reached on Monday - Friday, 9:00am - 5:00pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lin Ye can be reached on 571-372-7372. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

NHAN T. TRAN
Primary Examiner
Art Unit 2664

/NHAN T TRAN/
Primary Examiner, Art Unit 2664

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	15/324,720	Cohen et al.
	Examiner	**Art Unit**
	NHAN T TRAN	2664

CPC						
Symbol					**Type**	**Version**
H04N	/	5	/	23296	F	2013-01-01
H04N	/	5	/	2258	I	2013-01-01
H04N	/	5	/	23216	I	2013-01-01
H04N	/	5	/	23245	I	2013-01-01

CPC Combination Sets								
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE (Assistant Examiner) (Date)	**Total Claims Allowed:** 20	
/NHAN T TRAN/ 13 November 2018 Primary Examiner, Art Unit 2664 (Primary Examiner) (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1A & 3A

Issue Classification	Application/Control No. 15/324,720	Applicant(s)/Patent Under Reexamination Cohen et al.
	Examiner NHAN T TRAN	Art Unit 2664

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04N	/	5	/	232
H04N	/	5	/	225
	/		/	

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE (Assistant Examiner)	(Date)	Total Claims Allowed: 20	
/NHAN T TRAN/ Primary Examiner, Art Unit 2664 (Primary Examiner)	13 November 2018 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1A & 3A

U.S. Patent and Trademark Office

Part of Paper No.: 20181113

Issue Classification	Application/Control No. 15/324,720	Applicant(s)/Patent Under Reexamination Cohen et al.
	Examiner NHAN T TRAN	Art Unit 2664

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	10	10	18	19										
2	2	-	11	19	20										
3	3	11	12	20	21										
4	4	12	13												
5	5	13	14												
6	6	14	15												
7	7	15	16												
8	8	16	17												
9	9	17	18												

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 20	
/NHAN T TRAN/ Primary Examiner, Art Unit 2664 (Primary Examiner)	13 November 2018 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1A & 3A

U.S. Patent and Trademark Office

Part of Paper No.: 20181113

Search Notes	**Application/Control No.** 15/324,720	**Applicant(s)/Patent Under Reexamination** Cohen et al.
	Examiner NHAN T TRAN	**Art Unit** 2664

CPC - Searched*		
Symbol	**Date**	**Examiner**
H04N5/23296; H04N5/2258; H04N5/23216; H04N5/23245	6/10/2018	NT

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
EAST search in all available databases (see search history)	6/10/2018	NT
EAST text search in all groups and subgroups (see search history)	6/11/2018	NT
Inventorship search	6/11/2018	NT
Updated EAST text search (see search history)	11/13/2018	NT

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
ALL	Interference text search in USPAT and USPGPUB	11/13/2018	NT

/NHAN T TRAN/
Primary Examiner, Art Unit 2664

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2403	(detect$3 or determin$3 or if or when) near2 (object or subject or feature or target) near3 (clos$2 or distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:01
L2	5028	(wide near1 angle or wide) same lens same (telephoto or tele) same (dual or two) same (lens or imag$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:01
L3	3594	L2 same zoom$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:01
L4	297	L3 same (switch$3 or transition$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:01
L5	257	L4 and @ad<"20150813"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:01
L7	5015	(object or subject or feature) near3 (clos$2 or short adj1 distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:21
L8	48	L7 and (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 (lens or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/11/13 14:21
S1	0	("15324720").PN.	US-PGPUB;	OR	OFF	2018/06/10

			USPAT; USOCR			16:31
S2	10660	H04N5/23296.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S3	6676	H04N5/2258.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S4	10722	H04N5/23216.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S5	12379	H04N5/23245.cpc.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/10 16:36
S6	23	"2014199338"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:17
S7	6	"20030017930"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:29
S8	6	(("20030017930") or ("20090102950") or ("20080030592") or ("20100277619") or ("20110064327") or ("20150244942")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/11 11:30
S9	1	("20030179303").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/11 11:32
S10	4	(("8401276") or ("6104432") or ("5710670") or ("9185291")).PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/11 11:34
S11	4890	(wide near1 angle or wide) same lens same (telephoto or tele) same (dual or two) same (lens or imag$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT;	OR	ON	2018/06/11 11:37

			IBM_TDB			
S12	3503	S11 same zoom$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:37
S13	287	S12 same (switch$3 or transition$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:38
S14	256	S13 and @ad<"20150813"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 11:38
S15	9	(transition$3 or switch$3 or shift$3) near3 digital near2 zoom$4 with (telephoto or tele) near3 (lens or optical or imag$3 near2 sens$3 or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:09
S16	74503	fixed near1 focal with wide wth (telephoto or tele) same (dual or two)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:36
S17	3561	(transition$3 or switch$3 or shift$3) with wide with (tele or telephoto or zoom$4 adj1 in)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:36
S18	502	S16 same S17	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:37
S19	32	S18 same (digital or electronic) near2 (zoom or magnification)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 12:38
S20	150	fixed with wide with (tele or telephoto) with (dual or two) with (lens or optic$3 or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2018/06/11 13:35

			JPO; DERWENT; IBM_TDB			
S21	18	S20 same (switch$3 or transition$3 or shift$3)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 13:35
S22	293	(shift$3 near3 image) with wide with (tele or telephoto)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:19
S23	0	S22 same (registration or register) with global	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:20
S24	4	S22 and (registration or register) with global	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:20
S25	37579	(disparity or misalign$4) with image	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/11 14:21
S26	274	switch$3 near2 (camera or tele or telephoto or long near1 focal) with resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 15:42
S27	0	S26 with (digital near1 zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:15
S28	0	S26 with ((digital or electronic) near1 zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:15
S29	49	(wide or short near2 focal) near2 (camera or lens or optic$3) with (tele or	US-PGPUB; USPAT;	OR	ON	2018/06/12 16:17

		telephoto or long near2 focal) with (switch$3 or transition$3 or shift$3) with condition	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S30	431	(wide or short near2 focal) near2 (camera or lens or optic$3) with (tele or telephoto or long near2 focal) with (switch$3 or transition$3 or shift$3) with (condition or zoom$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:17
S31	7	S30 same (digital or electronic) near2 (zoom$4 or magnification or enlargement) with resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:18
S32	145	resolution with (wide or short near1 focal) near2 imag$3 with (tele or telephoto or long near1 focal)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:21
S33	1	S32 same threshold	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:21
S34	49	(dual near2 (camera or imag$3 near2 sens$3) with wide with (tele or telephoto))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:23
S35	27	S34 and resolution	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 16:24
S36	0	("14386823").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 16:24
S37	1	("20150085174").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 16:25
S38	1	("9800798").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 17:28
S39	16	("20020152557" | "20060139463" | "20060187312" | "20060187338" | "20070025713" | "20080024596" | "20080030592" | "20090295949" |	US-PGPUB; USPAT; USOCR	OR	ON	2018/06/12 17:28

		"20110249086" | "20130235234" | "20130250159" | "20140184854" | "20140232905" | "5870139" | "7561191" | "8456515").PN. OR ("9800798").URPN.				
S40	5	S34 and (disparity or parallax or misalign$4)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:38
S41	5	effective near2 resolution with image with (digital or electronic) near2 zoom$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:44
S42	147	detect$3 near2 (object or subject or feature) near3 (clos$3 or short adj1 distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S43	0	S42 with (switch$3 or chang$3 or shift$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S44	0	S42 same (switch$3 or chang$3 or shift$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:49
S45	4797	(object or subject or feature) near3 (clos$2 or short adj1 distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:50
S46	1	S45 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 (lens or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:50
S47	47	S45 and (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 (lens or camera)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:51
S48	0	S45 same (switch$3 or chang$3 or	US-PGPUB;	OR	ON	2018/06/12

		shift$3 or driv$3) near2 wide near2 mode	USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			17:53
S49	4978	(object or subject or feature or target) near3 clos$2 near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 17:55
S50	0	S49 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:06
S51	2278	(detect$3 or determin$3 or if or when) near2 (object or subject or feature or target) near3 (clos$2 or distance) near2 camera	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:07
S52	0	S51 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide near2 mode	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:08
S53	0	S51 same (switch$3 or chang$3 or shift$3 or driv$3) near2 wide	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:08
S54	10	(switch$3 or shift$3 or chang$3) near3 (wide or short near2 focal) near3 (zoom$3 or close-up or closeup or long near1 focal) with (detect$3 near3 (object or subject or target))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/12 18:17
S55	1	("20090022276").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2018/06/12 22:35
S56	311	(Cohen near2 Noy or Gigushinski near2 Oded or GEva near1 Nadav or Shabtay near1 Gal or Ashkenazi near2 Ester or Katz near1 Ruthy or Goldenberg near1 Ephraim).in.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/06/13 00:00

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L9	1	(zoom$4 and digital$2 and fixed and focal and length and wide and (telephoto or tele) and factor and low$3 and high$3 and switch$3 and (criteria or criterion)).clm.	US-PGPUB; USPAT	OR	ON	2018/11/13 14:39

11/13/2018 2:40:48 PM
C:\Users\ntran1\Documents\EAST\Workspaces\15324720.wsp

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9286680	B1	2016-03-15	Jiang et al.	
	2	9736391	B2	2017-08-15	Du et al.	
	3	9894287	B2	2018-02-13	Qian et al.	
	4	6750903	B1	2004-06-15	Miyatake et al.	
	5	5032917	A	1991-07-16	Felix Aschwanden	
	6	5287093	A	1994-02-15	Amano et al.	
	7	5287093	A	1995-02-28	John T. Hall	
	8	5444478	A	1995-08-22	Lelong et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /NAPL/

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	9	5657402	A	1997-08-12	Bender et al.	
	10	5682198	A	1997-10-28	Katayama et al.	
	11	5926190	A	1999-07-20	Turkowski et al.	
	12	6128416	A	2000-10-03	Koutatsu Oura	
	13	6148120	A	2000-11-14	Michael Sussman	
	14	6208765	B1	2001-03-27	James Russell Bergen	
	15	7002583	B2	2006-02-21	Maurice F. Rabb, III	
	16	7346217	B1	2008-03-18	V. Edward Gold, Jr.	
	17	7424218	B2	2008-09-09	Baudisch et al.	
	18	7533819	B2	2009-05-19	Barkan et al.	
	19	7619683	B2	2009-11-17	Raymond A. Davis	

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	20	6268611	B1	2001-07-31	Pettersson et al.	
	21	6714665	B1	2004-03-30	Hanna et al.	
	22	5005083	A	1991-04-02	Grage et al.	
	23	5940641	A	1999-08-17	McIntyre et al.	
	24	6741250	B1	2004-05-25	Furlan et al.	
	25	7365793	B2	2008-04-29	Cheatle et al.	
	26	9413930	B2	2016-08-09	Joergen Geerds	
	27	4199785	A	1980-04-22	McCullough et al.	
	28	8400555	B1	2013-03-19	Georgiev et al.	
	29	8553106	B2	2013-10-08	Lawrence Scarff	
	30	9800798	B2	2017-10-24	Ravirala et al.	

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	31	5768443	A	1998-06-16	Michael et al.	
	32	6101334	A	2000-08-08	Stephen D. Fantone	
	33	6611289	B1	2003-08-26	Yu et al.	
	34	7015954	B1	2006-03-21	Foote et al.	
	35	7256944	B2	2007-08-14	Labaziewicz et al.	
	36	8587691	B2	2013-11-19	Yasuo Takane	
	37	8274552	B2	2012-09-25	Dahi et al.	
	38	8390729	B2	2013-03-05	Long et al.	
	39	8803990	B2	2014-08-12	Scott Smith	
	40	9270875	B2	2016-02-23	Brisedoux et al.	
	41	9485432	B1	2016-11-01	Medasani et al.	

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	42	5436660	A	1995-07-25	Yukio Sakamoto	
	43	6549215	B2	2003-04-15	Norman P. Jouppi	
	44	7411610	B2	2008-08-12	Michael Doyle	
	45	8439265	B2	2013-05-14	Ferren et al.	
	46	5248971	A	1993-09-28	William J. Mandl	
	47	5459520	A	1995-10-17	Tadao Sasaki	
	48	7038716	B2	2006-05-02	Klein et al.	
	49	7339621	B2	2008-03-04	Justin Fortier	
	50	9215385	B2	2015-12-15	Xiaodong Luo	
	51	7305180	B2	2007-12-04	Labaziewicz et al.	
	52	7978239	B2	2011-07-12	Deever et al.	

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	53	7199348	B2	2007-04-03	Olsen et al.	
	54	8115825	B2	2012-02-14	Culbert et al.	
	55	7964835	B2	2011-06-21	Olsen et al.	
	56	8154610	B2	2012-04-10	Jo et al.	
	57	8619148	B2	2013-12-31	Watts et al.	
	58	5051830	A	1991-09-24	Wolfgang von Hoessle	
	59	5982951	A	1999-11-09	Katayama et al.	
	60	6738073	B2	2004-05-18	Park et al.	
	61	9025073	B2	2015-05-05	Attar et al.	
	62	9025077	B2	2015-05-05	Attar et al.	
	63	9413984	B2	2016-08-09	Attar et al.	

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	64	9578257	B2	2017-02-21	Attar et al.	
	65	9681057	B2	2017-06-13	Attar et al.	
	66	7206136	B2	2007-04-17	Labaziewicz et al.	
	67	7509041	B2	2009-03-24	Eiji Hosono	
	68	8976255	B2	2015-03-10	Matsuoto et al.	
	69	9041835	B2	2015-05-26	Yoshiaki Honda	
	70	9723220	B2	2017-08-01	Kazuhiko Sugie	
	71	8483452	B2	2013-07-09	Ueda et al.	
	72	9137447	B2	2015-09-15	Koji Shibuno	
	73	7880776	B2	2011-02-01	LeGall et al.	
	74	9618748	B2	2017-04-11	Munger et al.	

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	75	9019387	B2	2015-04-28	Akira Nakano	
	76	8446484	B2	2013-05-21	Muukki et al.	
	77	8238695	B1	2012-08-07	Davey et al.	
	78	6680748	B1	2004-01-20	John Mario Monti	
	79	9344626	B2	2016-05-17	Silverstein et al.	
	80	9420180	B2	2016-08-16	Chongting Jin	
	81	8391697	B2	2013-03-05	Cho et al.	
	82	9438792	B2	2016-09-06	Nakada et al.	
	83	9215377	B2	2015-12-15	Sokeila et al.	
	84	9360671	B1	2016-06-07	Changyin Zhou	
	85	9736365	B2	2017-08-15	Rajiv Laroia	

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	86	9851803	B2	2017-12-26	Fisher et al.	
	87	6778207	B1	2004-08-17	Lee et al	
	88	8514491	B2	2013-08-20	Jacques Duparre	
	89	98896655	B2	2014-11-25	Mauchly et al.	
	90	9369621	B2	2016-06-14	Malone et al.	
	91	9900522	B2	2018-02-20	Yuesheng Lu	
	92	8547389	B2	2013-10-01	Hoppe et al.	
	93	7738016	B2	2010-06-15	Toshiyuki Toyofuku	
	94	7918398	B2	2011-04-05	Li et al.	
	95	7248294	B2	2007-07-24	David Neil Slatter	
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See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

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A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Menachem Nathan/	Date (YYYY-MM-DD)	2018-09-23
Name/Print	Menachem Nathan	Registration Number	65392

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*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through a citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Menachem Nathan/	Date (YYYY-MM-DD)	2018-11-25
Name/Print	MENACHEM NATHAN	Registration Number	65392

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	COREPH-0159 US NP
First Named Inventor	Noy Cohen
Title	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NO
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☐ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☐ **Specification** [*Total Pages* ____]
   Both the claims and abstract must start on a new page.
   (See MPEP § 608.01(a) for information on the preferred arrangement)
5. ☐ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* ____]
6. **Inventor's Oath or Declaration** [*Total Pages* ____]
   (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))
   a. ☐ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
7. ☐ **Application Data Sheet** ** See note below.*
   See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R**
   in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission**
   (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
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ACCOMPANYING APPLICATION PAPERS

10. ☐ **Assignment Papers**
    (cover sheet & document(s))
    Name of Assignee ____
11. ☐ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☐ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☑ **Information Disclosure Statement**
    (PTO/SB/08 or PTO-1449)
    ☑ Copies of citations attached
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15. ☐ **Return Receipt Postcard**
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17. ☐ **Nonpublication Request**
    Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. ☑ **Other:** Remarks - This is an IDS. Citation or identification of any reference in this IDS shall not be construed as an admission that such reference is available as prior art.

***Note**: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

☑ The address associated with Customer Number: 92342 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Menachem Nathan/	Date	11-25-2018
Name (Print/Type)	MENACHEM NATHAN	Registration No. (Attorney/Agent)	65,392

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Electronic Acknowledgement Receipt

EFS ID:	34384532
Application Number:	15324720
International Application Number:	
Confirmation Number:	5811
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
Filer:	Menachem Nathan
Filer Authorized By:	
Attorney Docket Number:	COREPH-0159 US NP
Receipt Date:	25-NOV-2018
Filing Date:	08-JAN-2017
Time Stamp:	07:41:03
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Information Disclosure Statement (IDS) Form (SB08)	IDS.pdf	1035180 7263bcf854eb5c2aa1c3826b7653ac5258aecde4	no	5

Warnings:

Information:					
2	Transmittal Letter	IDS_TF.pdf	277478 ed837153e1547f8196079274b9dc07f288213e23	no	2
Warnings:					
Information:					
3	Foreign Reference	FR.pdf	1840502 73e4d885d9cca5618c05f5aa4575de536d365162	no	44
Warnings:					
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			Total Files Size (in bytes):	3153160	

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National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
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(19) Europäisches Patentamt
European Patent Office
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(11) EP 1 536 633 A1

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(54) **Photographing apparatus and method, supervising system, program and recording medium**

(57) The motion of a moving subject is captured at a short time interval up to a wide area by tracking and photographing the moving subject. A wide angle area is photographed by a first camera, an area narrower than the wide angle area is photographed by a second camera, the presence or absence of the motion in an image is detected by a motion detecting section by comparing the first image with the second image in terms of the difference of luminance levels. The correlation of the positions of the first image and the second image is recorded by a memory, and the photographing direction of the second camera is controlled by a controller by using the correlation information when the presence of the motion is detected by the motion detecting section.

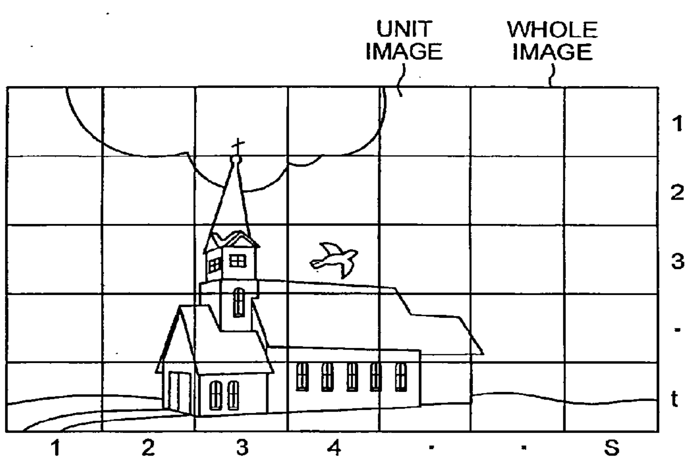


FIG. 1

EP 1 536 633 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a photographing apparatus and method, a supervising system, a program and a recording medium which supervise a state of a wide range through a panoramic image obtained by photographing by sequentially altering a photographing direction.

[0002] This application claims priority of Japanese Patent Application No. 2003-398152, filed on November 27, 2003 and Japanese Patent Application No. 2004-266014, filed on September 13, 2004, the entireties of which are incorporated by reference herein.

2. Description of Related Art

[0003] An electronic still camera which has been, heretofore, widely used, converts a light passed through a lens by photographing a subject into an image signal through a solid state imaging element, such as a CCD (Charge Coupled Device) and the like, records the image signal in a recording medium and can reproduce the recorded image signal. Most of electronic still cameras each has a monitor which can display the photographed still image, and can selectively display the specific one of the still images recorded so far. In this electronic still camera, the image signal supplied to the monitor corresponds to the subject on each screen. Therefore, the simultaneously displayed images become a narrow range, and the electronic still camera cannot simultaneously supervise the state of a wide range.

[0004] Therefore, a supervisory camera which can supervise the states of a wide range by obtaining the whole panoramic image formed of a plurality of unit images by photographing a subject while sequentially shifting the photographing direction of the camera prevails. Particularly, in recent years, a technique for contracting and synthesizing a plurality of image signals to an image signal of one frame has been proposed (for example, refer to Patent Document No. 1 of Japanese Patent Application Laid-Open Publication No. 10-108163). Also, a centralized supervisory recording system which can realize a supervision by gathering supervisory images from a plurality of supervisory video cameras installed and recording the images in a recording medium, such as a video tape and the like has been proposed (for example, refer to Patent Document No. 2 of Japanese Patent Application Laid-Open Publication No. 2000-243062).

[0005] When a photographing range as shown in FIG. 1 is, for example, photographed at a predetermined photographing angle of view by a conventional supervisory camera, it is necessary to photograph a subject by sequentially shifting the photographing direction in a horizontal or vertical direction. If the size of the photographing range can be expressed by ($s \times t$) times as large as the size of a frame (hereinafter referred to as a "unit image") obtained by photographing the size of the photographing range at the above-mentioned photographing angle of view, it is necessary to set at least ($s \times t$) ways of the photographing directions.

[0006] Actually, the photographing direction of the supervisory camera is first matched to the coordinates (1, 1) disposed at an upper left side, and the photographing is executed. Then, the photographing direction of this supervisory camera is sequentially altered to the coordinates (2, 1), (3, 1), (4, 1),..., (s, 1) in the horizontal direction and the photographing is executed. After the photographing of a first row is finished, the photographing direction is regulated to the coordinates (1, 2) of a second row, and the photographing is executed. Thereafter, the photographing is executed while sequentially shifting the photographing direction in the horizontal direction. Such an operation is repeated, the photographing is executed to the coordinates (s, t). Thereafter, the unit images of the ($s \times t$) pieces are laminated, and the whole image expressing the entire photographing range can be synthesized.

[0007] However, the supervisory camera as the conventional art needs to photograph all of the ($s \times t$) pieces of the unit images constructing the whole image of one sheet to generate the whole image. Particularly, there is a problem that even small state change occurring in a short time in the photographing range cannot be captured without exception.

[0008] FIG. 2 shows the state that, as time is elapsed from time t1 to time t4, a moving subject (bird) having a fast moving speed gradually goes away from a building. When the unit images of the ($s \times t$) pieces for constructing the whole image at the time t1 shown in FIG. 2 are photographed, since the moving subject including the unit images for constituting the building, clouds or the like in which the moving subject does not exist need to be sequentially photographed, a long time is required.

[0009] As a result, when the whole image is photographed at next timing, the time might already reach the time t4. Thus, the states of the moving subject at the times t2 and t3 cannot be captured as the image data, and hence there is a problem that a practical effect of supervising via the supervisory camera cannot be planned.

[0010] Further, if this moving subject is deviated from the photographing range, there also is a problem that photographing of the subject by capturing the subject at any time cannot be continued.

SUMMARY OF THE INVENTION

[0011] Accordingly, the present invention has been made in view of the above-mentioned problems and has an object of providing photographing apparatus and method, supervising system, a program and a recording medium which can capture the motion of a moving subject at a short time interval up to a wide area by tracking and photographing the moving subject in the photographing apparatus and method, the supervising system, the program and the recording medium which photograph the respective unit images constructing the whole image expressing the entire photographing range to supervise the state of a wide photographing range.

[0012] In order to solve the above-mentioned problems, a wide angle area is photographed by a first camera, an area narrower than the wide angle area in a direction corresponding to the designated photographing direction is photographed by a second camera, the presence or absence of the motion in the image is detected by a motion detecting section by comparing a first image generated by the first camera with the previous image photographed previously from the first image in terms of the difference of a luminance level, correlation information showing the correlation of the positions of the first image and a second image obtained by the second camera is previously recorded by a memory, and the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section is controlled by a controller.

[0013] That is, the photographing apparatus according to the present invention comprises: a first camera for photographing a wide angle area; a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction; a motion detecting section for detecting the presence or absence of a motion in the image by comparing a first image generated by the first camera with the previous image photographed previously from the first image in terms of the difference of a luminance level; a memory for previously recording correlation information showing the correlation of the positions of the first image and a second image obtained by the second camera, and a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section.

[0014] The photographing apparatus according to the present invention comprises: a first camera for photographing a wide angle area; a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction; a motion detecting section for detecting the presence or absence of a motion at each unit image by comparing a first unit image constructing a first wide angle image generated by the first camera with the unit image in the same photographing direction photographed previously from the first unit image in terms of the difference of a luminance level; a recording section previously recording correlation information showing correlation of the respective image positions between the first unit image and the second unit image obtained by the second camera; and a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detection section.

[0015] The photographing method according to the invention comprises: a step of photographing a first image of a wide angle area by a first camera; a step of photographing a second image of an area narrower than the wide angle area by a second camera; and a motion detecting step of detecting the presence or absence of the motion in the image by comparing the first image with the previous image photographed previously from the first image in terms of a luminance level; controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first image and the second image obtained by the second camera.

[0016] The photographing method according to the present invention comprises: a step of photographing a first wide angle image of a wide angle area by a first camera; a step of photographing a second image of an area narrower than the wide angle area by a second camera; and a motion detecting step of detecting the presence or absence of the motion in the image at each unit image by comparing a first unit image constructing the first wide angle image with a unit image in the same photographing direction previously photographed from the unit image in terms of the difference of a luminance level; controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first unit image and a second unit image obtained by the second camera.

[0017] A supervising system according to the invention comprises: a first camera for photographing a wide angle area; a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction; a motion detecting section for detecting the presence or absence of a motion at each unit image by comparing a first unit image constructing a first wide angle image generated by the first camera with the unit image in the same photographing direction photographed previously from the first unit image in terms of the difference of a luminance level; a recording section previously recording correlation information showing correlation of the respective image positions between the first unit image and a second unit image obtained by the second camera; and a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section.

[0018] A program according to the present invention causes a computer to execute: a step of photographing a first image of a wide angle area by a first camera; a step of photographing a second image of an area narrower than the wide angle area by a second camera; and a motion detecting step of detecting the presence or absence of the motion in the image by comparing the first image with the previous image photographed previously from the first image in terms of a luminance level; controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first image and the second image obtained by the second camera.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a view for explaining an example of a unit image constructing a whole panoramic image;
FIG. 2 is a view for explaining the problems of a conventional art;
FIG. 3 is a view showing a supervising system applied by the present invention;
FIG. 4 is a block diagram of cameras and a supervising unit;
FIG. 5 is a view for explaining a detailed structure of a whole image forming section;
FIG. 6 is a view for explaining the case that a photographing range shown by a rectangular frame is photographed by a camera unit at a photographing angle of view u;
FIG. 7 is a view showing the structural example of a display screen on a display;
FIG. 8 is a view showing a normal photographing mode and a tracking and photographing mode in a time series manner;
FIG. 9 is a view for explaining the normal photographing mode and the tracking and photographing mode in further detail;
FIG. 10 is a flowchart for explaining the sequence of obtaining a tracking photographing position by a tracking position calculating section;
FIG. 11 is a view for explaining setting of a supervising frame when a parking place is supervised;
FIG. 12 is a flowchart for explaining a photographing sequence by an entire photographing camera;
FIG. 13 is a flowchart for explaining an operating sequence of a difference sensing section;
FIG. 14 is a view for explaining the case that relative positions in a supervising area defined by points A to D of an image position E are identified;
FIG. 15 is a flowchart showing the photographing operation sequence of the tracking photographing section to which a tracking image position E' is notified;
FIG. 16 is a view for explaining an application example of a supervising system to which the present invention is applied;
FIG. 17 is a view showing another structure of a supervising system to which the present invention is applied;
FIG. 18 is a view showing still another structure of the supervising system to which the present invention is applied;
FIG. 19 is a view showing a structure of a supervising system in which a fixed camera is used for the entire photographing camera;
FIG. 20A is a front view showing a disposition example of the fixed camera and the tracking photographing camera in the above-mentioned supervising system, and FIG. 20B is a side view thereof;
FIG. 21 is a view showing an image of all directions of 360° acquired in real time by the fixed camera in the above-mentioned supervising system;
FIG. 22 is a view showing a panoramic image formed by laminating images obtained by the tracking photographing camera in the above-mentioned supervising system;
FIG. 23 is a view showing an image space in the above-mentioned supervising system;
FIG. 24 is a view showing four points A, B, C and D on the image of all directions of 360° initially set in the supervising unit in the above-mentioned supervising system;
FIG. 25 is a view showing four points A', B', C' and D' of the panoramic image initially set in the supervising unit in the above-mentioned supervising system;
FIG. 26 is a flowchart showing the operation of the supervising unit in the above-mentioned supervising system; and
FIG. 27 is a sectional view of a visual angle in a vertical direction of the entire photographing camera and the tracking photographing camera in the above-mentioned supervising system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Now, preferred embodiment the present invention will be described in greater detail by referring to the accompanying drawings. The supervising system 1 to which the present invention is applied comprises: as shown, for example, in FIG. 3, an entire photographing camera 2 for generating an image signal by photographing a subject and a tracking and photographing camera 5, a network 8 connected to these cameras 2, 5, and a supervising unit 15 for controlling the entire photographing camera 2 and the tracking and photographing camera 5 through the connected network 8 or acquiring the image signals from the cameras 2 and 5.

[0021] The entire photographing camera 2 includes a pan tilter section 3 and a camera section 4 integrally constructed. The pan tilter section 3 is constructed as a rotating pedestal for freely altering the photographing direction at two axes of, for example, a pan and a tilt. The camera section 4 is arranged on the rotating pedestal constructing the pan tilter section 3 to photograph a subject while regulating the photographing direction in a horizontal or vertical direction under the control of the supervising unit 15. This camera section 4 sequentially alters the photographing angle of view in response to the control by the supervising unit 15, thereby enlarging or contracting a photographing magnification to photograph the subject.

[0022] This entire photographing camera 2 sequentially matches the photographing direction to the respective unit images constructing the panoramic image expressing the entire photographing range to execute the photographing, as shown in FIG. 3. Such unit images are transmitted as an image signal to the supervising unit 15 side through the network 8, and can thereby synthesize the whole image expressing the photographing range entirety by laminating the unit images.

[0023] The tracking and photographing camera 5 includes a pan tilter section 6, and a camera section 7 integrally constructed. Since the structures of the pan tilter section 6 and the camera section 7 are the same as the pan tilter section 3 and the camera section 4 in the entire photographing camera 2, the detailed description thereof will be omitted.

[0024] The supervising unit 15 is constructed of a personal computer (PC) and the like, and records the image signal transmitted from the entire photographing camera 2 through the network 8 in recording media, and displays the respective images based on the image signal recorded in the recording media for a user. The supervising unit 15 also judges the presence or absence of a motion by identifying a luminance component for the image signal transmitted from the entire photographing camera 2, and controls to switch a photographing mode in the entire photographing camera 2 in response to the judged result. Further, this supervising unit 15 serves as a so-called central control unit for controlling the network 8 entirety, and transmits an image and a voice in response to a request from another terminal unit (not shown).

[0025] The network 8 is a communication network which can transmit and receive information interactively, for example, like an internet network connected to the supervising unit 15 through a telephone channel, an ISDN (Integrated Services Digital Network)/B (broadband)- ISDN and the like connected to TA/modem. Incidentally, when this supervising system 1 is used in a predetermined narrow area, this network 8 may be constructed of a LAN (Local Area Network), or may be connected through an IEEE1394 interface and the like. Further, this network 8 may transmit even a moving image in addition to a still image. In such a case, a moving image, such as, for example, an MPEG (Moving Picture Experts Group) data is transmitted continuously from certain one channel based on an internet protocol (IP), and still image data is transmitted from another channel at regular time intervals. Note that, a network server (not shown) may be further connected to this network 8. This network server (not shown) manages, for example, internet information, receives request by a terminal unit, and transmits a predetermined information stored in itself.

[0026] Subsequently, the constructions of the entire photographing camera 2, the tracking and photographing camera 5, and the supervising unit 15 in the supervising system 1 to which the present invention is applied will be described in detail.

[0027] FIG. 4 is a structural view of the entire photographing camera 2, the tracking and photographing camera 5 and the supervising unit 15. In FIG. 4, the pan tilter section 3 constructing the entire photographing camera 2 includes a tilt section for controlling the rotating pedestal for altering the photographing direction and the pan section. The information regarding the position and the angle of the camera section 4 is transmitted by the connected azimuth sensor 25 to the pan tilter section 3. The camera section 4 constructing the entire photographing camera 2 includes a lens control section 23 for mainly altering the angle of view of the lens section 22, and an imaging section 24 arranged at a position perpendicular to the optical axis of the lens section 22.

[0028] Similarly, the pan tilter section 6 constructing the tracking and photographing camera 5 includes a tilt section for controlling the rotating pedestal for altering the photographing direction and a pan section. The information regarding the position and the angle of the camera section 52 is transmitted by the connected azimuth sensor 55 to this pan tilter section 6. The camera section 7 constructing the entire photographing camera 2 includes a lens control section 53 for mainly altering the angle of view of the lens section 52, and an imaging section 54 arranged at the position perpendicular to the optical axis of the lens section 52.

[0029] The supervising unit 15 includes a whole image forming section 31 for forming the whole panorama-like image (panoramic image) based on the image signal transmitted from the entire photographing camera 2 through the network 8, a difference sensing section 32 for detecting the motion of the whole image formed in the whole image forming section 31, a tracking and photographing control section 33 connected to the tracking and photographing camera 5 through the network 8 for controlling the tracking and photographing camera 5, a tracking position calculating section 34 for obtaining a tracking image position in response to the image position judged that the motion exists in the difference sensing section 32, a panorama setting database (DB) 35 connected to at least the whole image forming section 31 and the tracking position calculating section 34 for recording a correlation information showing a correlation at respective image positions among unit images obtained from the entire photographing camera 2 and the tracking and photographing camera 5, a correlation information forming section 36 for forming the above-mentioned correlation information, a tracking and photographing conditions setting section 38 for setting conditions for tracking and photographing (hereinafter, referred to as "tracking and photographing conditions"), and a tracking and photographing conditions DB 39 for recording the tracking and photographing conditions set in the above-mentioned tracking and photographing conditions setting section 38.

[0030] The pan tilter section 3 rotates a stepping motor constructed as a drive source of the rotating pedestal based on a drive signal from the whole image forming section 31. Since the rotating pedestal itself can be turned in a horizontal direction or a vertical direction in this manner, the photographing direction of the camera section 4 placed on the rotating pedestal can be turned in the horizontal direction or the vertical direction.

[0031] The lens control section 23 executes an automatic diaphragm control operation and an automatic focusing control operation for the lens section 22 based on the drive signal from the whole image forming section 31. This lens control section 23 alters the photographing angle of view to the subject based on such a drive signal. Thus, the camera section 4 sequentially regulates a photographing magnification to thereby photographing the subject.

[0032] The imaging section 24 includes a solid state imaging element, such as, a CCD (Charge Coupled Device) and the like, focuses a subject image incident through the lens section 22 on an imaging surface, and generates an image signal by a photoelectric conversion. The imaging section 24 transmits the generated image signal to the whole image forming section 31.

[0033] The pan tilter section 6 rotates a stepping motor constructed as a drive source of the rotating pedestal based on the drive signal from the tracking and photographing control section 33. Thus, the photographing direction of the camera section 7 placed on the rotating pedestal can be turned in the horizontal direction or the vertical direction.

[0034] The lens control section 53 executes an automatic diaphragm control operation and an automatic focusing control operation for the lens section 52 based on the drive signal from the tracking and photographing control section 33. This lens control section 53 alters the photographing angle of view to the subject based on such a drive signal. Thus, the camera section 4 sequentially regulates a photographing magnification to thereby photographing the subject.

[0035] The imaging section 54 includes, for example, a solid state imaging element, such as, a CCD (Charge Coupled Device) and the like, focuses a subject image incident through the lens section 52 on an imaging surface, and generates an image signal by a photoelectric conversion. The imaging section 54 transmits the generated image signal to the tracking and photographing control section 33.

[0036] The whole image forming section 31 executes predetermined control through the network 8 so that the photographing direction can be gradually altered at the imaging time by the entire photographing camera 2 to realize photographing of a wide range. This whole image forming section 31 creates the whole panorama-like image of one sheet by laminating the unit images photographed by the entire photographing camera 2. The whole image forming section 31 records the formed whole image, and reads the image in response to the request of the difference sensing section 32.

[0037] The difference sensing section 32 detects the motion of the whole image formed in the whole image forming section 31. The difference sensing section 32 notifies the detected result of the motion to the tracking position calculating section 34 and the tracking and photographing control section 33. Incidentally, the difference sensing section 32 may inquire this motion detecting conditions to the tracking and photographing conditions DB 39.

[0038] The tracking and photographing control section 33 controls the photographing direction, the photographing angle of view and the like of the tracking and photographing camera 5 through the network 8 based on the motion detected result and the like notified from the difference sensing section 32. The tracking and photographing control section 33 acquires the unit image photographed by the tracking and photographing camera 5 through the network 8.

[0039] The panorama setting section 36 includes a keyboard, a mouse and the like for a user to input desired information to form the above-mentioned correlation information.

[0040] The tracking and photographing conditions setting section 38 includes a keyboard, a mouse and the like for setting the conditions of the motion detection to be stored in the tracking and photographing conditions DB 39.

[0041] Next, the detailed structure of the whole image forming section 31 will be described.

[0042] The whole image forming section 31 includes, as shown in FIG. 5, an A/D conversion section 61 connected to the entire photographing camera 2 through the network 8, an encoder 63 connected to this A/D conversion section 61, a recording media 66 for storing the image outputted from the encoder 63, a decoder 67 for expanding the image read from the recording media 66, a monitor image processing section 68 connected to the A/D conversion section 61 and the decoder 67 for forming the image to be displayed for a user, a memory 69 for temporarily storing the image supplied from the connected monitor image processing section 68, a D/A conversion section 74 for converting the signal inputted from the connected monitor image processing section 68 into an analog signal, and a control section 70 for controlling respective constituting elements.

[0043] Incidentally, a monitor 75 including a liquid crystal display screen and the like and displaying predetermined information for a user is connected to the D/A conversion section 74. An operating section 76 for designating a desired image area and an image position by a user from the image displayed on the monitor 75 is connected to the control section 70.

[0044] The A/D conversion section 61 digitizes the image signal transmitted from the entire photographing camera 2, and transmits the digitized image signal to the encoder 63, the difference sensing section 32, and the monitor image processing section 68.

[0045] The encoder 63 performs compression and coding based on the standards, such as, JPEG (Joint Photographic Experts Group) and the like. Incidentally, this encoder 63 may add position information or meta data to the image signal to be compressed and coded. The encoder 63 outputs the compressed and coded image signal to the recording media 66. Incidentally, when the supplied image signal is not subjected to compressing and coding, the process in the encoder 63 is omitted.

[0046] The recording media 66 is applied, for example, as a hard disc, a detachable disc-like recording medium and the like, the image signal outputted from the encoder 63 is sequentially recorded in association with position information or meta data. The image signal recorded in the recording media 66 is read based on the control by the control section 70 and is transmitted to the decoder 67. Incidentally, the image signal recorded in a memory card can be transferred to the other PC by controlling to record the image signal recorded in the recording media 66 into a memory card (not shown). The recording media 66 can be replaced with a network server (not shown) by controlling to record the image signal recorded in the recording media 66 into the above-mentioned network server (not shown).

[0047] The decoder 67 expands the image signal of the JPEG format read from the recording media 66, and transmits the image signal to the monitor image processing section 68.

[0048] The monitor image processing section 68 executes picture processing to the monitor 75 based on the image signal transmitted from the A/D conversion section 61 or the decoder 67 under the control of the control section 70. The monitor image processing section 68 executes the control of a contrast, a luminance in the monitor 75 based on the control by the control section 70. This monitor image processing section 68 executes thinning process of pixels for displaying a plurality of images on a liquid crystal display screen in the monitor 75 simultaneously by cooperating with the memory 69.

[0049] The control section 70 transmits a drive signal for driving the pan tilter section 3 and the lens control section 23, and a control signal for controlling the respective units in the supervising unit 15 when the image area and the image position are designated by a user through the operating section 76. This control section 70 receives a request from other terminal unit through the network 8, selects optimum still image, moving image or various information recorded in the recording media 66, and controls to transmit the image or the information to the terminal unit.

[0050] The monitor 75 includes, for example, a liquid crystal display element, a back light and the like (not shown), and is an interface for visually recognizing the image photographed by the user. The liquid crystal display element is irradiated with an illumination light by the above-mentioned back light from the back surface of the liquid crystal display element, and the visibility of the monitor 75 can be entirety improved.

[0051] The operating section 76 includes a keyboard, a mouse and the like for a user to designate a desired image area and an image position from the image displayed on the monitor 75. Incidentally, the operating section 76 may take the structures of the panorama setting section 36 and/or the tracking and photographing conditions setting section 38, as a result, the section 36 and/or section 37 may be, as a matter of course, omitted.

[0052] Then, the operation until the whole image is formed by this whole image forming section 31 will be described.

[0053] FIG. 6 shows the case that a photographing range shown by a rectangular frame is photographed by a photographing angle of view u by the entire photographing camera 2. To photograph all the photographing range by the photographing angle of view u, it is necessary to sequentially shift the photographing direction in a horizontal direction or a vertical direction. If the size of the photographing range is expressed by ($i \times j$) times as large as the sizes of the frame (hereinafter referred to as a "unit image") obtained by photographing the size of the photographing range at an arbitrary photographing angle of view u, it is necessary to set the photographing directions of at least the ($i \times j$) ways. The whole image expressing the entire photographing range can be synthesized by laminating the ($i \times j$) pieces of the unit images photographed at this photographing angle of view u.

[0054] Here, when the coordinates (M, N) of the respective unit images of the photographing range are sequentially indicated from a left end in the horizontal direction by 1, 2,..., M,.., i, and from an upper end in the vertical direction by 1, 2,.., N,.., j, the control section 70 transmits a predetermined drive signal to the pan tilter section 3. Thereby, the photographing direction of the camera section 4 is first matched to the coordinates (1, 1) disposed at an upper left side, and the camera section 4 executes imaging. The image signal based on the unit images generated by imaging this coordinates (1, 1) is A/D converted by the A/D conversion section 61, and then stored in the memory 69 through the monitor image processing section 68. The image signal is compression coded based on the JPEG standards in the encoder 62, meta data and the like are simultaneously added, and sequentially recorded in the recording media 66.

[0055] Similarly, the control section 70 transmits the drive signal to the pan tilter section 3, thereby shifts the photographing direction of the camera section 4 to a right side by one image frame, and executes photographing by matching to the coordinates (2, 1). The image signal generated by photographing this coordinates (2, 1) is similarly recorded in the recording media 66. The camera section 4 sequentially alters the photographing direction to the coordinates (3,1), (4, 1),.., (i, 1) in the horizontal direction based on the control by the control section 70, and executes photographing.

[0056] After the camera section 4 finishes the photographing of a first row, the camera section 4 executes photographing by regulating the photographing direction to the coordinates (1, 2) of a second row, thereafter executes photographing while sequentially shifting the photographing direction in the horizontal direction based on the control by the control section 70. When such an operation is repeated and the photographing is finished to the coordinates (i, j), the memory 69 and the recording media 66 become the state that the image signals based on the (i × j) pieces of the unit images photographed at the respective coordinates are recorded. Incidentally, after the photographing to the coordinates (i, j) is finished, the control section 70 transmits the drive signal to the pan tilter section 3, and thereby executes the photographing at next timing by matching the photographing direction of the camera section 4 to the coordinates (1, 1) disposed again at the upper left side.

[0057] It should be noted that the sequence of photographing the unit images is not limited to the above-mentioned example. For example, after the photographing of the first row is finished, the photographing direction is regulated to the coordinates (i, 2) of a second row based on the control by the control section 70, the photographing is executed, and, thereafter, the photographing direction may be shifted toward the coordinates (1, 2).

[0058] The image signals based on the respective unit images recorded in the memory 69 are sequentially read by the monitor image processing section 68, and reduced to be matched to the size of the display screen in the monitor 75. This reduced respective unit images are displayed on the monitor 75 through the D/A conversion section 74. All the unit images of the (i × j) pieces recorded in the memory 69 are displayed on the monitor 75, and thereby one panorama-like image is synthesized. The above-mentioned photographing operation is executed at a predetermined interval, and thereby the whole image showing the latest state of the photographing range can be acquired.

[0059] Further, when the unit images recorded in the recording media 66 before are to be displayed on the monitor 75 is designated by the control section 70, the image signals based on the unit images from the recording media 66 are sequentially read, enlarged by the decoder 67, and transmitted to the monitor image processing section 68. The image signal is reduced to be matched to the size of the display screen as described above in the monitor image processing section 68, synthesized to the whole panorama-like image, and displayed.

[0060] FIG. 7 shows an example of displaying the whole image synthesized by laminating the photographed unit images of the (i × j) pieces on the entire image display section 170 of the monitor 75. Incidentally, this supervising unit 15 may display a boundary between the respective unit images for constructing the whole image on the entire image display section 170, or may display only a seamless entire image. The supervising unit 15 may cause to display the whole image of one sheet photographed at the photographing angle of view, the entire photographing range of which can be captured instead of the whole panorama-like image on this entire image display section 170.

[0061] Incidentally, an enlarged image display section 171 for displaying the enlarged image obtained by enlarging the unit image is further provided in the display screen 45. This enlarged image display section 171 may enlarge and display one unit image designated by the user of the unit images constructing the whole image displayed on the whole image display section 170. Or, moving images may be sequentially displayed with respect to the photographing direction of such a unit image. Thus, the user can confirm the state of the photographing direction of the designated unit image in real time.

[0062] On the display screen 45, a WIDE button 172 for displaying the unit image displayed on the enlarged image display section 171 by reducing the photographing magnification, and a ZOOM button 173 for enlarging the photographing magnification and displaying the image are displayed. On this display screen 45, a photographing direction control section 175 for regulating the photographing direction of the camera section 4 in horizontal direction and vertical direction, and a set button 176 or the like for recording the image signal based on the unit image on a desired address in case of setting various modes or a server, is displayed.

[0063] The user can designate a desired image area, an image position to the entire image display section 170 and the enlarged image display section 171 through the operating section 176. It should be noted that an aiming line or a pointer for executing the above-mentioned designating operation may further be displayed by cooperating with the motion of a mouse or the like in the operating section 176 on the respective display sections 170, 171.

[0064] In the supervising system 1 to which the present invention is applied, in addition to the normal photographing mode for synthesizing the whole image displaying the whole photographing range by laminating the unit images of (i × j) pieces photographed by the entire photographing camera 2 as described above, a tracking and photographing mode for capturing the desired moving subject and continuously photographing the moving subject at any time by the tracking and photographing camera 5 is incorporated. In this tracking and photographing mode, the whole image is generated at a short time interval. Thus, the motion of the moving subject such as a bird displayed on the entire image display section 170 in FIG. 7 is captured as an image signal without leakage.

[0065] FIG. 8 shows a normal photographing mode and a tracking and photographing mode in time series. Since the photographing direction is sequentially matched to all the unit images for constructing the whole image and photographing is executed in the normal photographing mode, it takes a long time until one whole image is synthesized. As a result, the number of the whole images which can be generated at a unit time (hereinafter referred to as a "refresh rate") is reduced.

[0066] On the other hand, in the tracking and photographing mode, since it is sufficient to photograph only one or more unit images including the tracking image position by capturing the moving subject, the photographing can be finished in a short time as compared with the normal photographing mode, and the refresh rate can be raised.

[0067] In the supervising system 1 to which the present invention is applied, when the photographing operation of the subject is started, photographing by the normal photographing mode is first executed. In this case, the difference sensing section 32 judges, as shown in FIG. 8, the presence or absence of the motion between the photographed unit image and the unit images in the same photographing direction constructing the previous whole image. As a result, if the unit image judged that there is the motion is exist by the difference sensing section 32, the fact is notified to the tracking position calculating section 34 and the tracking photographing control section 33 as the suggestion of the presence of the moving subject, and the tracking and photographing mode is initiated.

[0068] Incidentally, in this tracking and photographing mode, the tracking image position in the unit image al judged that there is a motion by the difference sensing section 32, a unit image b1 is generated by tracking photographing by the tracking and photographing camera 5. In such a case, since there is the case that an installing environment, a photographing direction and the like are different from each other between the entire photographing camera 2 and the tracking and photographing camera 5, and, therefore, the photographing directions between the cameras 2 and 5 are matched by referring to the correlation information recorded in the panorama setting DB 35 in the tracking position calculating section 34. In fact, this tracking position calculating section 34 matches the photographing directions between the cameras 2 and 5 through the calculated tracking image positions. Thus, the tracking and photographing camera 5 is scanned by the pan tilting in the photographing direction designated from the tracking position calculating section 34 through the tracking photographing control section 33. Thereby, the acquired unit image 1b can be matched to the unit image al. The detailed procedure for matching the photographing directions of the cameras 2 and 5 through the tracking image positions will be described later.

[0069] Incidentally, the difference sensing section 32 may use not only the whole image photographed at the previous timing as the previous whole image to be compared with newly photographed unit image with respect to a luminance level, but also the whole image stored in advance. In such a case, the use of any whole image is previously set under any conditions by the tracking and photographing condition setting section 39, and this may be recorded in the tracking and photographing condition DB.

[0070] When the tracking and photographing mode is started, photographing is executed by two cameras in parallel with the normal photographing mode. For example, as shown in FIG. 9, as time is elapsed from time t1 to t4, in the case that the moving subject (bird) having a fast moving speed is gradually separated from a building, since it is necessary to sequentially photograph including the unit images for constructing the building, clouds and the like where the moving subject does not exist, it requires a long time, in the normal photographing mode, when the unit images of ($s \times t$) pieces constructing the whole image is photographed at the time t1.

[0071] As a result, in this normal photographing mode, there might be the case that the time already reaches t4 when the whole image is photographed at next timing, and, therefore, the state of the moving subject at times t2, t3 cannot be captured as image data.

[0072] On the contrary, in the tracking and photographing mode, since only the unit images including the moving subject may be sequentially photographed, the state of the moving subject at the times t2, t3 are sequentially imaged, and can be stored. Even when this moving subject is deviated from the photographing range, this subject can be captured at any time by the tracking and photographing camera 5, and can be continuously photographed. As a result, in the tracking and photographing mode, as shown in FIG. 9, the unit images photographed only in the area in the frame at the times t1 to t4 can be obtained, and the slight state change occurring for a short time can be captured without exception.

[0073] Then, the procedure for obtaining the tracking image position by the tracking position calculating section 34 will be further described in detail.

[0074] First, in step S11 shown in FIG. 10, the unit image is photographed by the entire photographing camera 2 and the tracking and photographing camera 5 while the photographing direction is turning at 340° in a tilt direction. The unit images photographed by the respective cameras 2 and 5 are transmitted to the whole image forming section 31, and are recorded in the recording media 66. It is noted that the turning angle is not limited to 340°, but may be any angle.

[0075] Then, the operation is transferred to step S 12, the unit images photographed by turning the cameras 2 and 5 at 340° in step S11 are laminated to form the whole image. The formed respective whole images are displayed on the monitor 75.

[0076] Then, the operation is transferred to step S13, a user specifies a desired area to be supervised from the whole image displayed on the monitor 75 in step S12. In such a case, the user designates the area desired to be supervised by the operating section 76 from the whole image displayed on the monitor 75.

[0077] FIG. 11A shows the part of the whole image from the unit image photographed by the entire photographing camera 2 when a parking lot is supervised. FIG. 11B shows the part of whole image photographed by the tracking and photographing camera 5 installed at a different position. In step S12, the user sets the area desired to be supervised for the whole image shown in FIG. 11A, for example, in a frame for connecting points A to D (hereinafter referred to as a supervising "frame"). This supervising frame becomes the above-mentioned photographing range. Similarly, in this step S12, the user sets points A' to D' so that the objects to be photographed correspond to the above-mentioned A to D for the whole image shown in FIG. 11B. These sets are called supervising frame sets.

[0078] Incidentally, the supervising frame set of the points A to D and the points A' to D' may be set manually via the operating section 76. Alternatively, it may be automatically performed based on, for example, luminance information and the like.

[0079] Then, the operation is transferred to step S13, the points A to D set at the supervising frame in step S12 and the points A' to D' are finely regulated to show the same image position. In such a case, the names, the coordinates, setting names and the like of the respective set points are finely regulated to coincide between the points A to D and A' to D'. This fine regulations may be corresponded between the points A to D and the points A' to D'. Thus, not only the set points A to D and the points A' to D', but also between the image positions in the supervising frame, can be corresponded to each other. Since the image positions are corresponded to each other, a relative movement in the other image position can be identified in response to the movement of one image position.

[0080] Then, the operation is transferred to step S14, and all the supervising frame sets are stored in the panorama setting DB35. That is, in this step S14, the correspondence between the set points A to D and the set points A' to D' is stored in the panorama setting DB 35 as the above-mentioned correlation information.

[0081] Incidentally, the entire photographing camera 2 and the tracking and photographing camera 5 are superposed on each other, and are arranged on substantially the same position, and, therefore, processes in the above-mentioned steps S11 to S14 can be processed.

[0082] According to the present invention, the processes to the above-mentioned steps S11 to S14 are executed before the actual supervising. In the actual photographing, the operation is executed based on the procedure shown in FIG. 12.

[0083] First, in step S21, the whole image forming section 31 reads the supervising frame set recorded in the panorama setting DB35, and identifies the photographing range.

[0084] Then, the operation is transferred to step S22. This whole image forming section 31 generates a drive signal for controlling the pan tilter section 3 based on the identified photographing range. This drive signal is transmitted to the pan tilter section 3, and thereby sequentially shifting the photographing range in the horizontal direction or the vertical direction in the identified photographing range to perform photographing.

[0085] Then, the operation is transferred to step S23, whether the photographing of all the unit images in the photographing range (supervising frame) is finished or not is judged. As a result, all the unit images are not yet finished to be photographed is judged, the photographing is continued, while if the finish is judged, the operation is transferred to step S24.

[0086] If the operation is transferred to step S24, the unit images are laminated to form the whole image. Then, the generated whole image is reformed, and may be displayed on the monitor 75.

[0087] Then, the operation is transferred to step S25, and the whole image forming section 31 notifies the effect of generating new whole image to the difference sensing section 32.

[0088] FIG. 13 shows the operating sequence of the difference sensing section 32 which receives such a notification.

[0089] First, in step S31, the difference sensing section 32 accesses to the tracking and photographing condition DB39, and thereby acquiring the tracking and photographing condition recorded in the tracking and photographing condition DB39.

[0090] Then, the operation is transferred to step S32, the difference sensing section 32 detects the motion based on the acquired tracking and photographing condition. The motion detection in this step S32 is executed by obtaining a differential value of the luminance levels between the newly generated whole image and the previously acquired whole image. In such a case, whether the differential value of the obtained luminance levels exceeds a preset threshold value or not is judged (Step S33). Here, when the differential value of the luminance levels exceeds a threshold value, the detection of the motion is judged, and the operation is transferred to step S34. On the other hand, when the differential value of the luminance levels is the threshold value or less, it is judged that the motion is not detected, and the process is finished. In such a case, the difference sensing section 32 acquires the above-mentioned threshold value from the tracking and photographing condition DB39 as the above-mentioned tracking and photographing condition. The accuracy of the motion detection is controlled according to how this threshold value is set. Therefore, this threshold value can be freely set through the tracking and photographing conditions setting section 38, and thereby the level and the accuracy of the motion detection may be freely regulated.

[0091] Then, the operation is transferred to step S34, the difference sensing section 32 accesses to the tracking position calculating section 34, and informs the image position E of the motion detection, that is, the coordinates (Ex, Ey) of the image area exceeding the threshold value by the differential value of the luminance level, to the tracking position calculating section 34. Then, the operation is transferred to step S35, and the difference sensing section 32 acquires the tracking image position calculated by the tracking position calculating section 34. Further, this difference sensing section 32 notifies the acquired tracking image position in step S36 to the tracking photographing control section 33.

[0092] Here, a method for calculating the tracking image position in step S35 will be explained in the above-mentioned steps S11 to S 14 with reference to the case that the supervising frame of the parking lot is set as an example.

[0093] First, the tracking position calculating section 34 reads the supervising frame set at the points A to D and the points A' to D' recorded in the panorama setting DB35. The coordinates of a point A read here is (Ax, Ay), the coordinates of a point B is (Bx, By), the coordinates of a point C is (Cx, Cy), and the coordinates of a point D is (Dx, Dy).

[0094] The tracking position calculating section 34 identifies a relative position in the supervising area defined by the points A to D of the image position E notified from the difference sensing section 32 in the above-mentioned step S34. In such a case, the relative position of the image position E may be expressed by a ratio (x1: x2) of a longitudinal direction and a ratio (y1:y2) of a lateral direction, as shown in FIG. 14A. In such a case, the ratio of the longitudinal direction and the ratio of the lateral direction can be expressed by formula 1 and formula 2 as below:

$$x1 : x2 \fallingdotseq Ex \times (Ax + Bx)/2 : Ex \times (Dx + Cx)/2 \qquad \text{(formula 1)}$$

$$y1 : y2 \fallingdotseq Ey \times (Ay + Cy)/2 : Ey \times (By + Dy)/2 \qquad \text{(formula 2)}$$

[0095] Thus, the relative position of the motion detected image position E can be obtained in the whole image photographed by the entire photographing camera 2.

[0096] Then, this tracking position calculating section 34 calculates what coordinates of the whole image corresponds to this image position E in the tracking and photographing camera 5. Here, as shown in FIG. 14B, the coordinates of the acquired point A' is (A'x, A'y), the coordinates of the acquired point B' is (B'x, B'y), the coordinates of the point C' is (C'x, C'y), and the coordinates of the point D' is (D'x, D'y). In the whole image of the tracking and photographing camera 5, the tracking image position corresponding to the above-mentioned image position E will be hereinafter the tracking image position E', and the coordinates will be (E'x, E'y).

[0097] In such a case, in the case of A'x ≧ B'x and D'x ≧ C'x, E'x can be expressed by the following formula 3:

$$E'x \fallingdotseq ((C'x + (D'x-C'x) \times y1/(y1+y2)) - ((B'x + (A'x-B'x) \times y2/(y1+y2) \times x1/(x1+x2)) + B'x + (A'x-B'x) \times y2/(y1+y2) \qquad \text{(formula 3)}$$

[0098] In the case of D'y ≧ B'y and A'y ≧ C'y, E'y can be expressed by the following formula 4:

$$E'y \fallingdotseq ((B'y + (D'y-B'y) \times x1/(x1+x2)) - ((C'y + (A'y-C'y) \times x2/(x1+x2) \times y1/(y1+y2) + C'y + (A'y-C'y) \times x2/(x1+x2) \qquad \text{(formula 4)}$$

[0099] That is, the coordinates (E'x, E'y) of this obtained tracking image position E' corresponds to the coordinates (Ex,Ey) of the coordinates position E. Even if the entire photographing camera 2 and the tracking and photographing camera 5 are installed at different positions or are installed at different distance from a parking lot from each other, the coordinate position E' in the tracking and photographing camera 5 can be uniquely obtained from the coordinate position E motion detected from the entire image in the entire photographing camera 2.

[0100] The tracking position calculating section 34 can transmit the coordinates (E'x, E'y) of the obtained tracking image position E' as the tracking image position to the difference sensing section 32. The difference sensing section

32 transmits the coordinates (E'x, E'y) of the tracking image position E' to the tracking photographing control section 33. The tracking photographing control section 33 is set to include the coordinates (E'x, E'y) in the photographing direction of the tracking and photographing camera 5, and can match the photographing direction to the motion detected image position.

[0101] FIG. 15 shows the photographing operation sequence of the tracking photographing control section 33 to which such a tracking image position E' is notified.

[0102] First, in step S41, the tracking photographing control section 33 acquiring the tracking image position from the difference sensing section resets the photographing direction of the tracking and photographing camera 5 to include the coordinates (E'x, E'y). Then, the operation is transferred to step S42, a drive signal is transmitted to the tracking and photographing camera 5, and the photographing is started in the photographing direction.

[0103] The tracking and photographing camera 5 checks whether the signal for stopping the photographing is transmitted from the tracking and photographing control section 33 or not one by one. If the signal is transmitted, the photographing operation is stopped.

[0104] Such a supervising system 1 sets the supervising frame in no admittance area by the entire photographing camera 2 as shown, for example, in FIG. 16A as an application of particularly in supervising a parking lot. If a difference occurs at an illumination level from the previous entire image due to entrance of a person into this area, the photographing direction is matched to include the tracking image position by the tracking and photographing camera 5 as shown in FIG. 16B, and the tracking photographing is executed.

[0105] Such a supervising system 1 can be installed in a projection room of a multiplex movie theater so called a cinema complex. The entire image of the so called an empty state before audience sit is obtained, and the supervising frame is set to include the respective seats. Thus, a difference of the luminance level of the audience sitting on the seats occurs. As a result that the obtained difference value exceeds the threshold value, the photographing direction is matched to include the tracking image position, and the tracking photographing can be executed. Thus, when a person sits the reserved seat by comparing the selling information of tickets and reservation information of the seats, this can be traced.

[0106] In the above-mentioned embodiment, the case that the one entire photographing camera 2 for photographing the subject to generate the image signal and the one tracking and photographing camera 5 are provided has been explained as an example. However, the present invention is not limited to such a case. For example, one or more entire photographing cameras 2 and one or more tracking and photographing cameras 5 may be provided. FIG. 17 shows a supervising system 100 having three entire photographing cameras 2, and one tracking and photographing camera 5. In this supervising system 100, the same subject may be photographed from the different photographing directions by a plurality of entire photographing cameras 2, or the different subjects may be photographed. When the motion detection is performed by the entire photographing camera 2, the camera is transferred to the tracking and photographing mode, and the photographing by the tracking and photographing camera 5 is executed. The number and the ratio of the entire photographing camera 2 and the tracking and photographing camera 5 may be, of course, arbitrarily determined.

[0107] In the supervising system 1 to which the present invention is applied, the cameras 2 and 5 may not specify the roles as the entire photographing and the tracking photographing, but the entire photographing or the tracking photographing may be executed in response to the circumstances. In the supervisory camera 101 shown in FIG. 18, two cameras 2 and 5 are respectively arranged. Under the normal photographing mode, two cameras 2 and 5 respectively photograph the whole image. When any of the cameras 2 and 5 detects a motion, operation shifts to the tracking and photographing mode, and any one of the cameras 2 and 5 executes the tracking photographing.

[0108] In the supervising system 1 to which the present invention is applied, the comparison of the luminance levels of the above-mentioned unit images may be executed at respective primary colors of R, G and B. The comparison of the luminance levels is executed among the unit images in the same coordinates (M, N) as described above, in other words, among the unit images in the same photographing direction. Thus, the change of the luminance levels in the respective primary color components of the comparison entire image to the reference entire image, in other words, the differential values of the luminance levels in the respective primary color components can be detected in the respective photographing directions.

[0109] Further, the present invention is executed not only as the above-mentioned supervising system 1, but also, for example, the functions of the supervising unit 15 may be all carried at the camera side. In addition, the present invention may also be applied to a program for executing the above-mentioned process in a computer or a recording medium for recording such a program.

[0110] The present invention can also be applied to a supervising system 200 in which a fixed camera 2A for photographing an area of a wide range of 360 degrees as shown in FIG. 19 is used for the entire photographing camera 2 in the above-mentioned supervising system 1. This supervising system 200 includes the entire photographing camera 2A for generating an image signal by photographing a subject, a tracking and photographing camera 5, a network 8 connected to these cameras 2A, 5, and a supervising unit 15 for acquiring the image signal by controlling the entire photographing camera 2 and the tracking and photographing camera 5 via the connected network 8.

[0111] In this supervising system 200, the fixed camera 2A which can photograph in all directions of 360° in real time is used as the entire photographing camera 2, and this fixed camera 2A and tracking and photographing camera 5 which can perform pan/tilt/zoom are coaxially disposed as shown in FIGS. 20A and 20B.

[0112] FIG. 20A is a front view showing disposing examples of the fixed camera 2A and the tracking and photographing camera 5 in a front view and FIG. 20B is a side view thereof.

[0113] The image of all directions of 360° acquired in real time by the fixed camera 2A in this supervising system 200 is shown, for example, in FIG. 21, a pan direction angle of view of 360°, a tilt direction angle of view of 55° (an elevation angle: 38°, and a depression angle: 17°), and the number of pixels is about 1280 × 240 of image quality.

[0114] The panoramic image formed by laminating the images obtained by the tracking and photographing camera 5 has, for example, as shown in FIG. 22, a pan direction angle of view of 340°, a tilt direction angle of view of 51 ° (an elevation angle: 25.5°, and a depression angle: 25.5°), and the number of pixels is about 6400 × 960 of image quality.

[0115] In this supervising system 200, its image space is, as shown in FIG. 23, obtained by laminating image (VGA 10 × 2 sheets).

[0116] One image obtained by the tracking and photographing camera 5 is zoom regulated in advance so that a tilt direction becomes 25.5° and pan direction becomes 34°.

[0117] The supervising unit 15 of this supervising system 200 is executed by next initializing (1) and initializing (2) at the shipment.

> Initializing (1): A wide angle image space of a panoramic image in this supervising system 200 has a pan direction = 340°, a tilt direction = 51° of total angle of view. An image information is 6400 equally divided in a pan direction, and 960 equally divided in a tilt direction. This image information is stored in a panorama setting database of the supervising unit 15.
>
> Initializing (2): Four points of A, B, C and D are set on the image of 360° entire direction shown in FIG. 24 acquired in real time by the fixed camera 2A, and four points of A', B', C' and D' are set on the panoramic image shown in FIG. 25 formed by laminating the image obtained by the tracking and photographing camera 5. The above-mentioned four points are regarded as being the same position. This is also stored in the panorama setting database of the supervising unit 15.

[0118] In this supervising system 200, the tracking and photographing camera 5 is controlled based on the designating information on the image of the 360° entire direction acquired in real time by the fixed camera 2A according to the sequence shown in the flowchart of FIG. 26 by the supervising unit 15 initialized in this manner.

[0119] That is, the supervising unit 15 of this supervising system 200 acquires the coordinates on the 360° of the point E (X, Y) designated by the user with mouse paint (step S52), when the user designates an arbitrary point on the image of the 360° entire direction (step S51), positioning points A, B, C and D of the 360° entire direction image is acquired from the panorama setting database (step S53), positioning points A', B', C' and D' of the 340° panoramic image of the tracking and photographing camera 5 is acquired from the panorama setting database (step S54), the position information of the 340° panoramic image corresponding to the position E(X, Y) on the 360° entire direction image is acquired (step S55), a request for moving to the position of E(X', Y') is transmitted to the tracking and photographing camera 5 (step S56), and the image of moving destination is displayed (step S57).

[0120] That is, in this supervising system 200, when an arbitrary point E is clicked on the image of the 360° entire direction shown in FIG. 24, the coordinates E(X, Y) on the image of FIG. 24 is led, and the relative position (approximation) is calculated from the respective points of A, B, C and D stored in advance in the panorama setting database for the coordinates E (X, Y).

[0121] A', B', C' and D' of FIG. 25 stored in advance in the panorama setting database is regarded as being corresponded to the points of A, B, C and D, the E' (X', Y') of FIG. 25 corresponding to E (X, Y) of FIG. 24 is can be obtained from the relative positions of the A', B', C' and D' and the calculated A, B, C and D. The calculated E', (X', Y') is expressed as position information on the image information stored in the database.

[0122] Pan tilt control is performed so that the center of the image of the tracking and photographing camera 5 becomes E' based on the position information of this E' (X', Y').

[0123] Here, the calculation of the relative position (approximation) of the E arbitrarily designated on the image of the 360° entire direction acquired in real time by the fixed camera 2A in this supervising system 200 will be performed as follows:

$$X1 : X2 \fallingdotseq Ex - (Ax+Bx)/2 : (Dx+Cx)/2 - Ex$$

$$Y1 : Y2 \fallingdotseq Ey - (Ay+Cy)/2 : (By+Dy)/2 - Ey$$

[0124] The calculation of the position (approximation) of E' on the 340° panoramic image obtained by the tracking and photographing camera 5 is performed as follows:

[0125] The ratio X1:X2 of the relative position obtained in the previous calculation is 5:2, the ratio Y1:Y2 is 3:4, and the case where A'x >= B'x and D'x >= C'x,

$$E'x \fallingdotseq ((C'x+(D'x-C'x)*3/7)-(B'x+(A'x\ B'x)*4/7))*5/7+B'x+(A'x\ B'x)*4/7$$

[0126] The case where D'y>=B'y and A'y >= C'y,

$$E'y \fallingdotseq ((B'y+(D'y-B'y)*5/7)-(C'y+(A'y-C'y)*2/7))*3/7+C'y+(A'y-C'y)*2/7$$

[0127] Here, the visual field angle sectional view of a vertical direction of the entire photographing camera 2A and the tracking and photographing camera 5 in this supervising system 200 is shown in FIG. 27.

[0128] FIG. 27 shows a graphical expression of capturing a subject in a substantially equal direction (vertical direction) by both the entire photographing camera 2A, that is, a wide angle camera (Panorama Camera) and the tracking and photographing camera 5 in this supervising system 200.

[0129] First,

X: a horizontal direction distance of a photographing subject and a camera
Y: a vertical direction distance (height) which can be photographed in the entire tilt angle of view at a distance X
ΔY: distance between centers of imaging parts of two cameras.

[0130] As a premise, the following two premises exist.

Premise 1: the tracking and photographing camera 5 and 360° camera exist on substantially the same vertical line at the centers of the imaging parts of the cameras.
Premise 2: the tilt direction angle of view of the tracking and photographing camera 5 and the entire photographing camera 2A is regulated to the same angle of view in a range of about 55° to 65°.

[0131] In addition, the positional relation of two visual angles as shown in FIG. 27.

[0132] If the two angles of view are 55°,

$$\Delta Y = 100 \text{ mm of camera positional relation,}$$

When an article of the position of X = 10 m is photographed,

$$Y = 2*X*\mathrm{Tan}\ (55/2)° = 10.41 \text{ m}$$

is obtained. As a result,

$$\Delta Y/Y = 0.0096 = 0.96\%$$

is obtained,
Y: a difference of the position in the vertical direction between two cameras is very short with respect to the entire distance of the vertical direction. When two images are displayed by a monitor, it is not a level to feel the difference.

[0133] That is, the difference is mere about 5 dots when it is calculated in terms of VGA: 640 × 480.

[0134] Due to the coaxial layout, the angle of view of the horizontal direction is shared with the same angle of view in both cameras.

[0135] In this supervising system 200, the cameras 2A and 5 are coaxially disposed. Thus, the position calculating algorithm of the subject according to the relative positional relation of the cameras 2 and 5 is not required, but the point of the image of the 360° entire direction obtained by the photographing camera 2A is designated, and can be photographed by the tracking and photographing camera 5 of the image at the point as a center.

Claims

1. A photographing apparatus comprising:

a first camera for photographing a wide angle area;
a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction;
a motion detecting section for detecting the presence or absence of a motion in the image by comparing a first image generated by the first camera with the previous image photographed previously from the first image in terms of the difference of luminance levels;
a memory for previously recording correlation information showing the correlation of the positions of the first image and a second image obtained by the second camera; and
a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section.

2. The photographing apparatus according to claim 1, wherein the correlation information is an information obtained based on a plurality of predetermined positions of the first image and the second image.

3. The photographing apparatus according to claim 1, wherein the presence or absence of the motion is detected by the motion detecting section by comparing the difference of the luminance levels with a predetermined threshold value.

4. The photographing apparatus according to claim 1, wherein the first camera and the second camera are arranged at the substantially same positions.

5. The photographing apparatus according to claim 1, further comprising:

recording means for recording the photographed first image on a recording medium.

6. The photographing apparatus according to claim 1, wherein the first camera is a wide angle fixed camera, and the first image is the image of the entire photographing range of the first camera.

7. The photographing apparatus according to claim 1, wherein the first camera is a camera for photographing by sequentially matching the photographing direction to the respective unit images constructing the first image, and the first image is the image formed by connecting the respective unit images.

8. A photographing apparatus comprising:

a first camera for photographing a wide angle area;
a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction;
a motion detecting section for detecting the presence or absence of a motion at each unit image by comparing a first unit image constructing a first wide angle image generated by the first camera with the unit image in the same photographing direction photographed previously from the first unit image in terms of the difference of luminance levels;
a recording section previously recording correlation information showing correlation of the respective image positions between the first unit image and the second unit image obtained by the second camera; and
a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section.

9. The photographing apparatus according to claim 8, wherein the first camera is a camera for photographing by sequentially matching the photographing direction to a direction of each first unit image, and the first wide angle image is an image formed by connecting the first unit images.

10. A photographing method comprising:

a step of photographing a first image of a wide angle area by a first camera;
a step of photographing a second image of an area narrower than the wide angle area by a second camera; and
a motion detecting step of detecting the presence or absence of the motion in the image by comparing the first image with the previous image photographed previously from the first image in terms of a luminance level;
controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first image and the second image obtained by the second camera.

11. A photographing method comprising:

a step of photographing a first wide angle image of a wide angle area by a first camera;
a step of photographing a second image of an area narrower than the wide angle area by a second camera; and
a motion detecting step of detecting the presence or absence of the motion in the image at each unit image by comparing a first unit image constructing the first wide angle image with a unit image in the same photographing direction previously photographed from the unit image in terms of the difference of a luminance level;
controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first unit image and a second unit image obtained by the second camera.

12. A supervising system comprising:

a first camera for photographing a wide angle area;
a second camera for photographing an area narrower than the wide angle area in a direction corresponding to the designated photographing direction;
a motion detecting section for detecting the presence or absence of a motion at each unit image by comparing a first unit image constructing a first wide angle image generated by the first camera with the unit image in the same photographing direction photographed previously from the first unit image in terms of the difference of a luminance level;
a recording section previously recording correlation information showing correlation of the respective image positions between the first unit image and a second unit image obtained by the second camera; and
a controller for controlling the photographing direction of the second camera at the motion detected position by using the correlation information when the presence of the motion is detected by the motion detecting section.

13. A program for causing a computer to execute:

a step of photographing a first image of a wide angle area by a first camera;
a step of photographing a second image of an area narrower than the wide angle area by a second camera; and
a motion detecting step of detecting the presence or absence of the motion in the image by comparing the first image with the previous image photographed previously from the first image in terms of luminance levels;
controlling the photographing direction of the second camera at the motion detected position when the presence of the motion is detected by the motion detecting section by using the correlation information showing the correlation of the positions of the images of the first image and the second image obtained by the second camera.

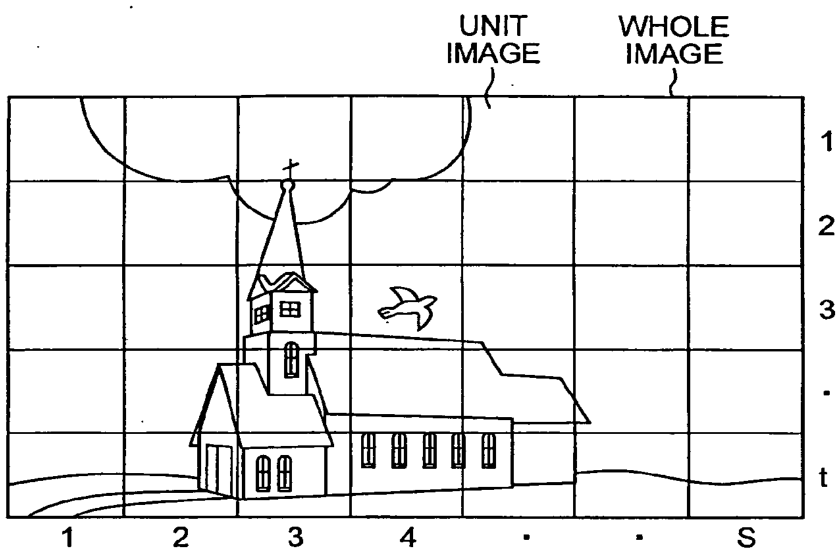


FIG. 1

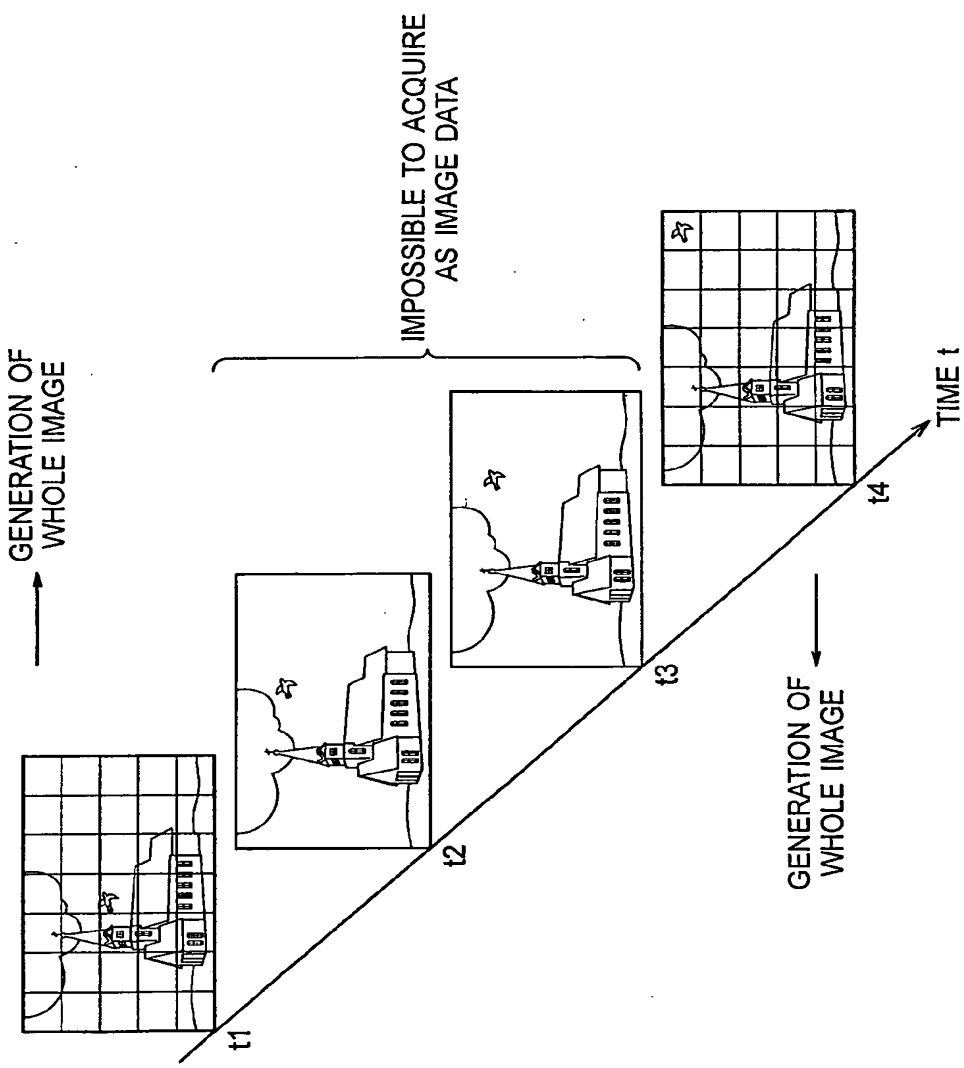

GENERATION OF
WHOLE IMAGE
IMPOSSIBLE TO ACQUIRE
AS IMAGE DATA
t1
t2
t3
t4
TIME t
GENERATION OF
WHOLE IMAGE

FIG. 2

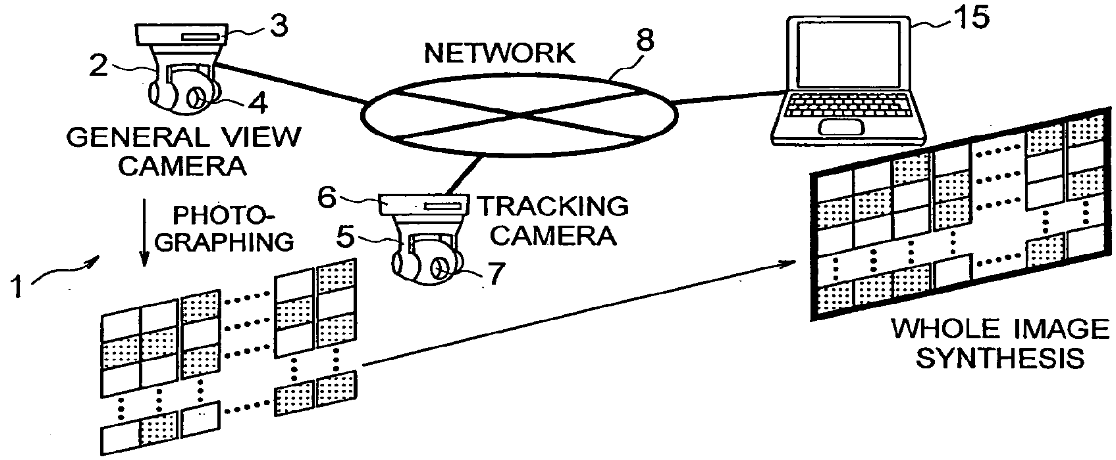
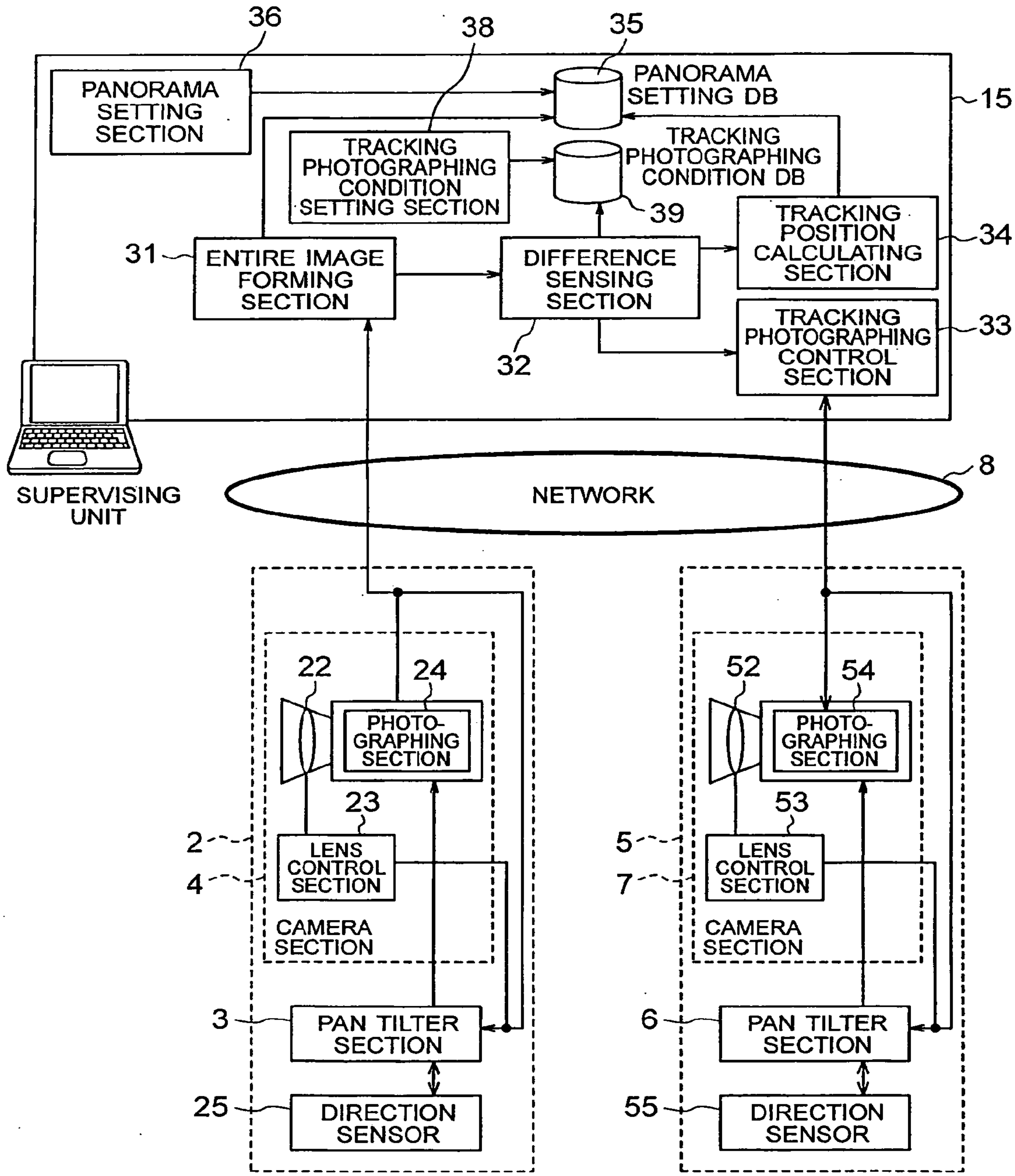

3
2
4
GENERAL VIEW CAMERA
NETWORK
8
15
6
TRACKING CAMERA
5
7
PHOTO-GRAPHING
1
WHOLE IMAGE SYNTHESIS

FIG. 3



36
38
35
PANORAMA SETTING SECTION
PANORAMA SETTING DB
15
TRACKING PHOTOGRAPHING CONDITION SETTING SECTION
TRACKING PHOTOGRAPHING CONDITION DB
39
TRACKING POSITION CALCULATING SECTION
34
31
ENTIRE IMAGE FORMING SECTION
DIFFERENCE SENSING SECTION
TRACKING PHOTOGRAPHING CONTROL SECTION
33
32
8
SUPERVISING UNIT
NETWORK
22
24
PHOTO-GRAPHING SECTION
23
2
4
LENS CONTROL SECTION
CAMERA SECTION
3
PAN TILTER SECTION
25
DIRECTION SENSOR
52
54
PHOTO-GRAPHING SECTION
53
5
7
LENS CONTROL SECTION
CAMERA SECTION
6
PAN TILTER SECTION
55
DIRECTION SENSOR

FIG. 4

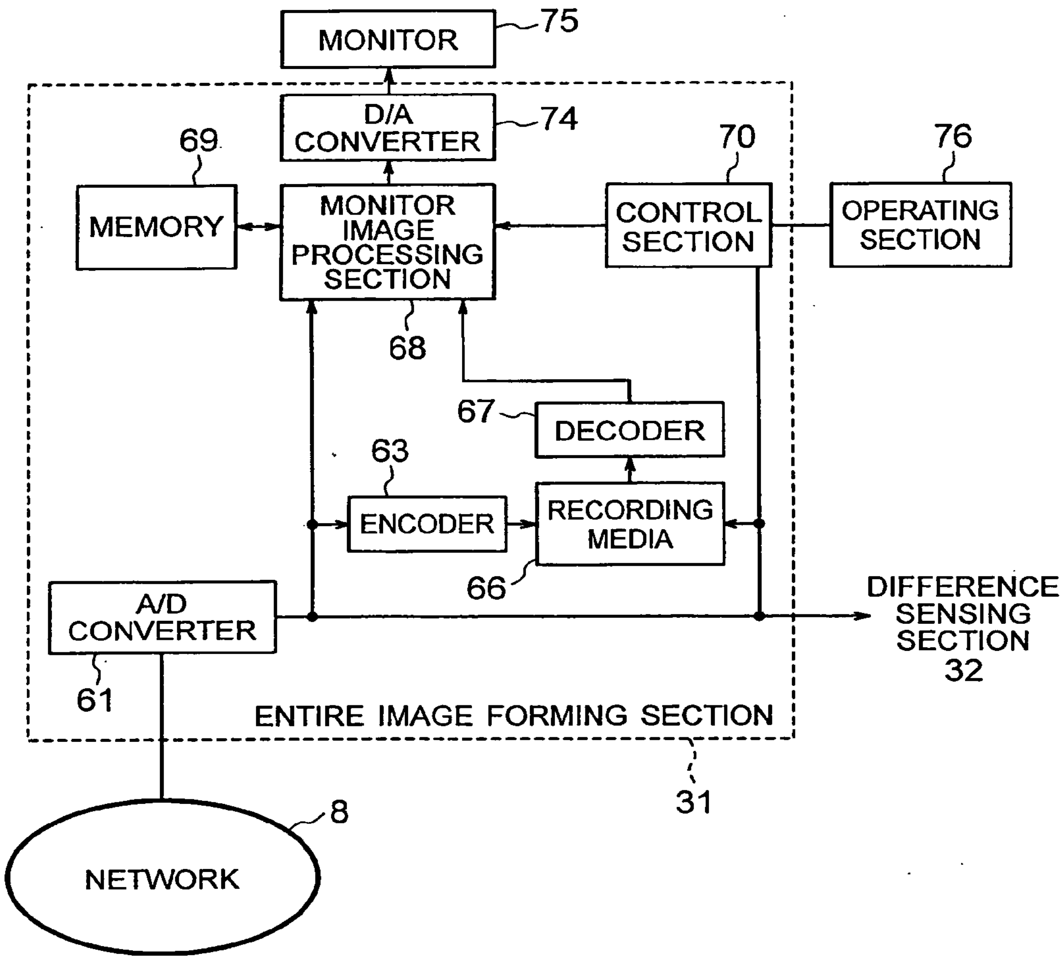

MONITOR
75
D/A CONVERTER
74
69
MEMORY
MONITOR IMAGE PROCESSING SECTION
68
70
CONTROL SECTION
76
OPERATING SECTION
67
DECODER
63
ENCODER
RECORDING MEDIA
66
A/D CONVERTER
61
DIFFERENCE SENSING SECTION
32
ENTIRE IMAGE FORMING SECTION
31
8
NETWORK

FIG. 5

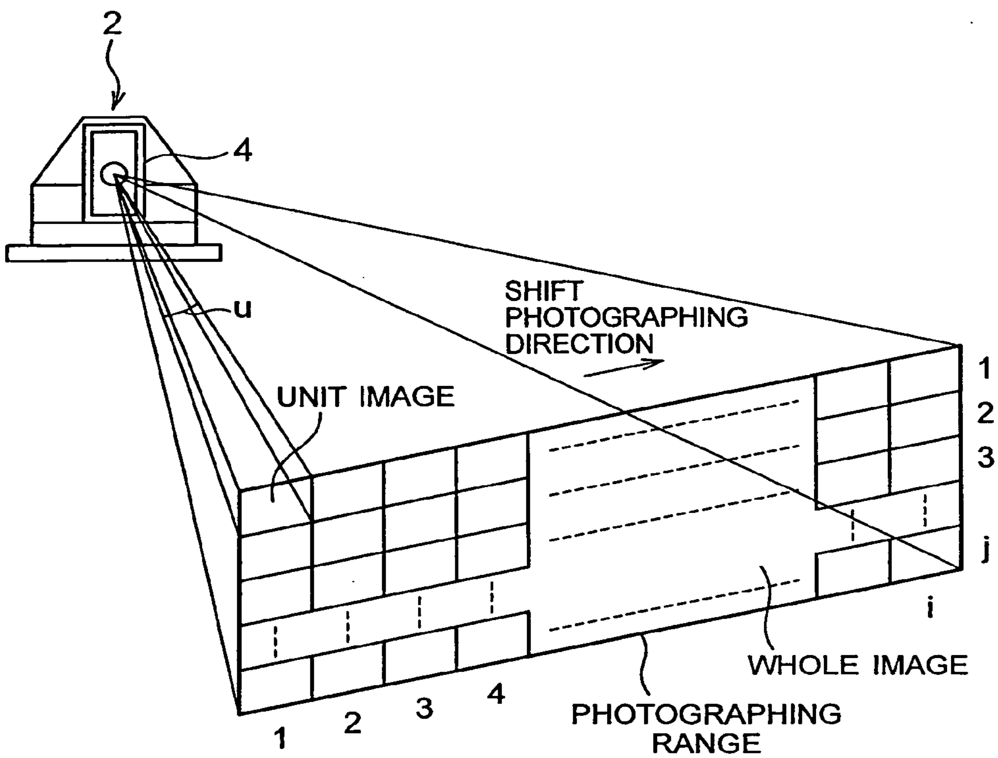

2
4
u
SHIFT
PHOTOGRAPHING
DIRECTION
UNIT IMAGE
1
2
3
j
i
WHOLE IMAGE
1
2
3
4
PHOTOGRAPHING
RANGE

FIG. 6

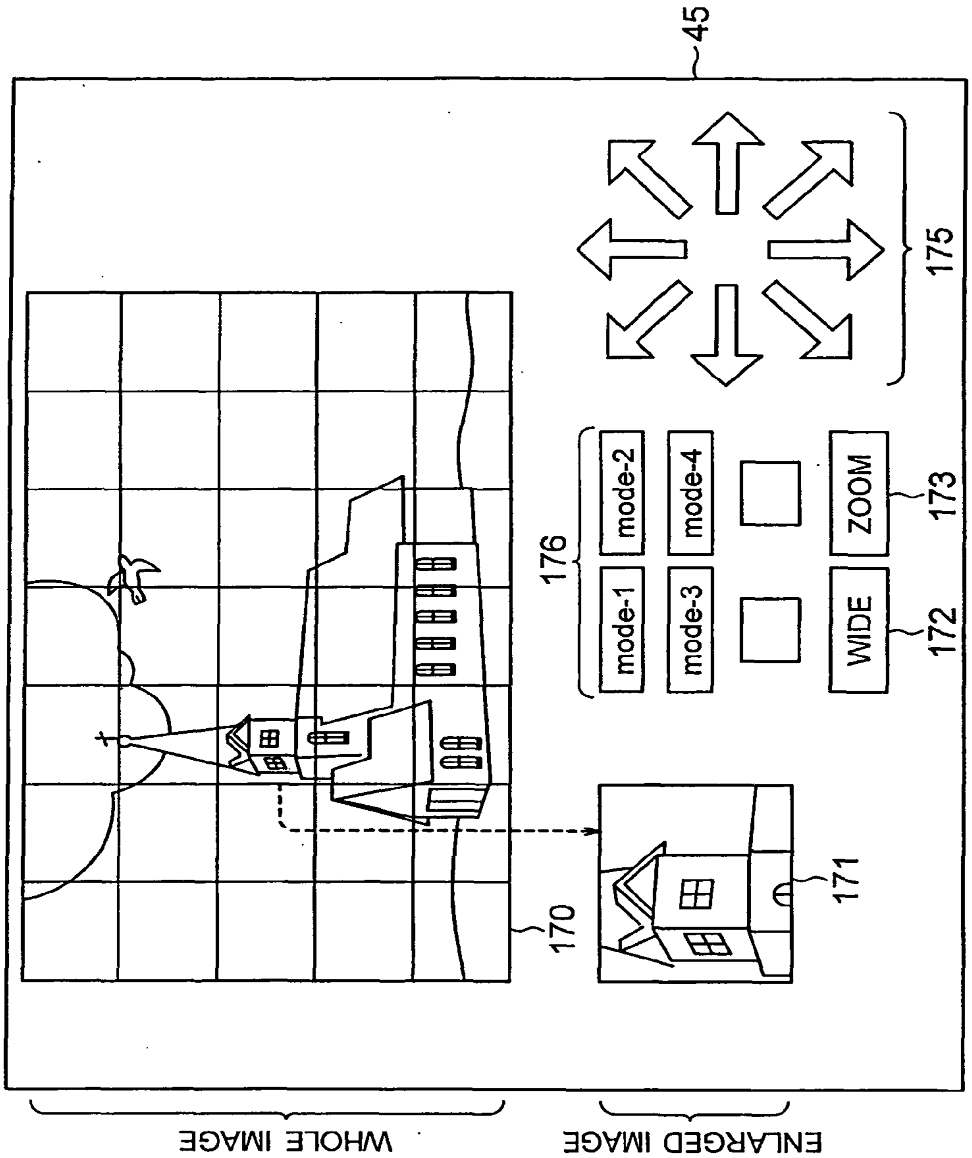

45
170
171
172
173
175
176
mode-1
mode-2
mode-3
mode-4
WIDE
ZOOM
WHOLE IMAGE
ENLARGED IMAGE

FIG. 7

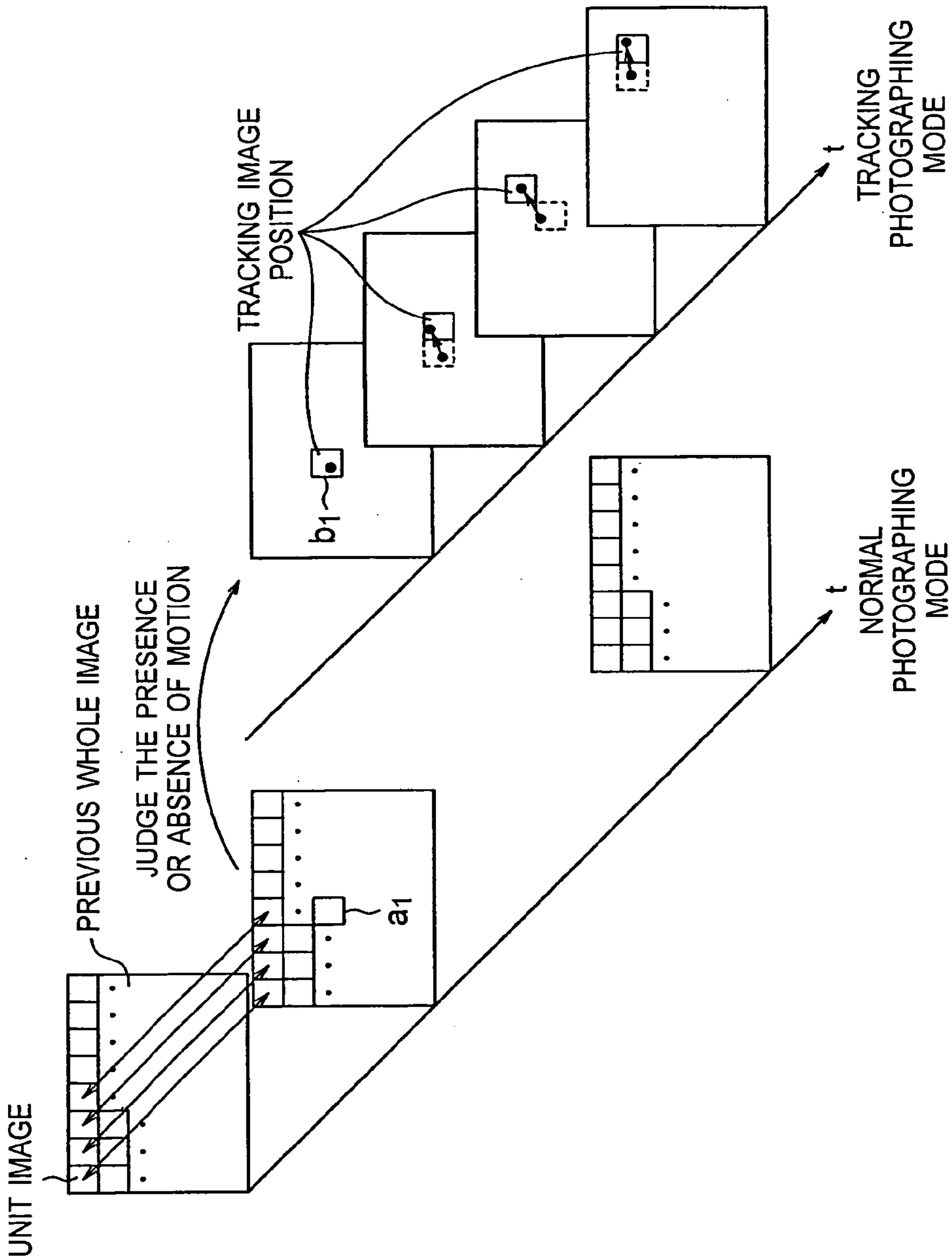

UNIT IMAGE
PREVIOUS WHOLE IMAGE
JUDGE THE PRESENCE OR ABSENCE OF MOTION
a_1
TRACKING IMAGE POSITION
b_1
t
NORMAL PHOTOGRAPHING MODE
t
TRACKING PHOTOGRAPHING MODE

FIG. 8

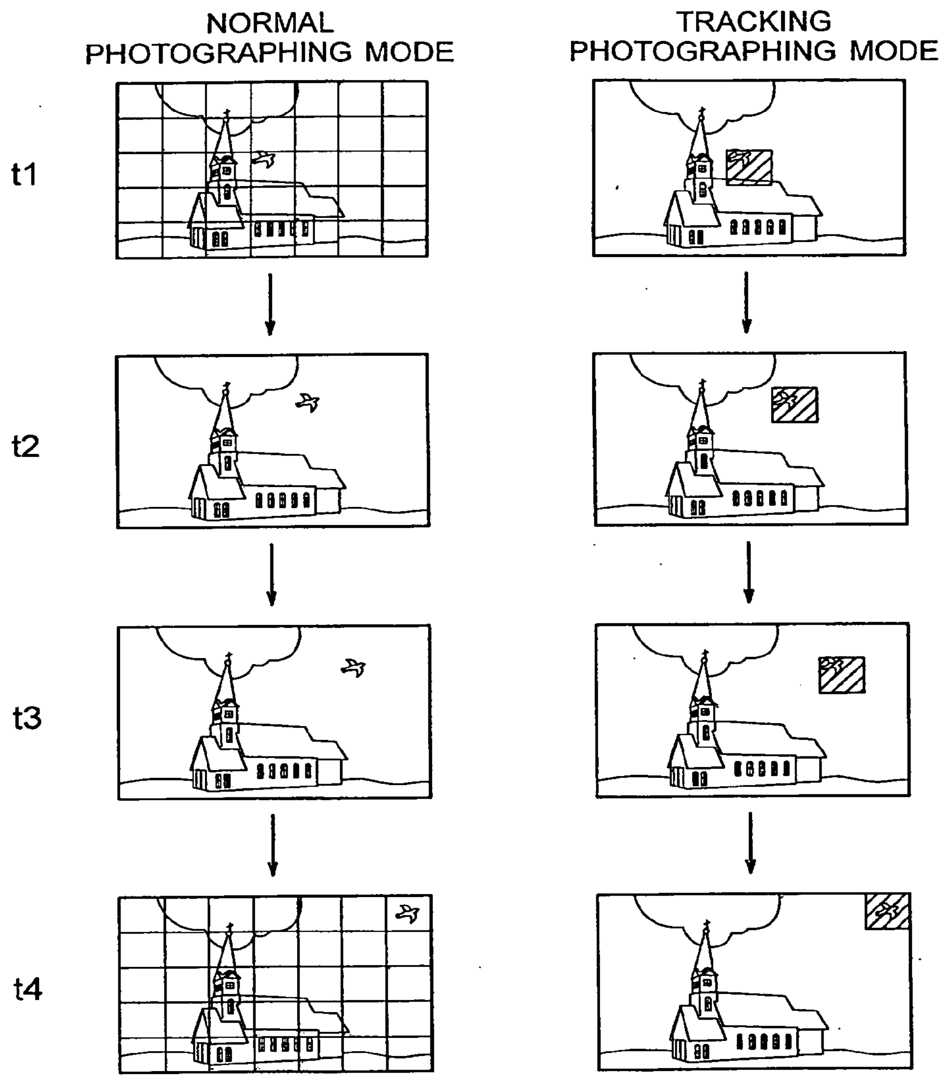

NORMAL
PHOTOGRAPHING MODE
TRACKING
PHOTOGRAPHING MODE
t1
t2
t3
t4

FIG. 9

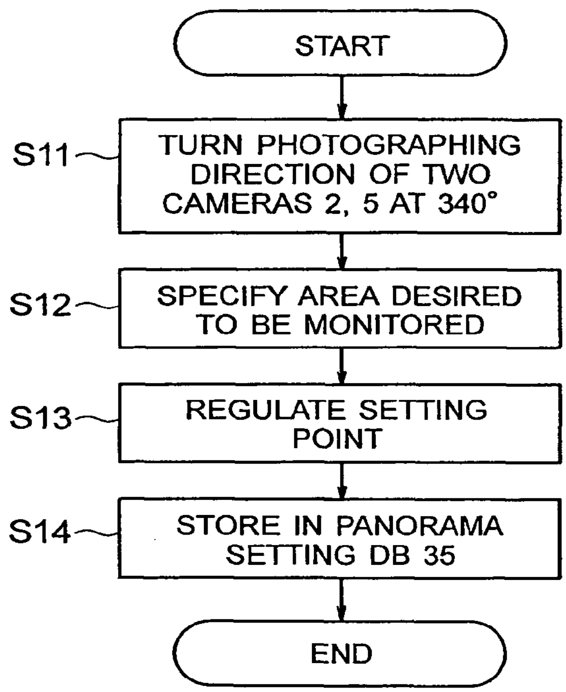

START
S11
TURN PHOTOGRAPHING DIRECTION OF TWO CAMERAS 2, 5 AT 340°
S12
SPECIFY AREA DESIRED TO BE MONITORED
S13
REGULATE SETTING POINT
S14
STORE IN PANORAMA SETTING DB 35
END

FIG. 10

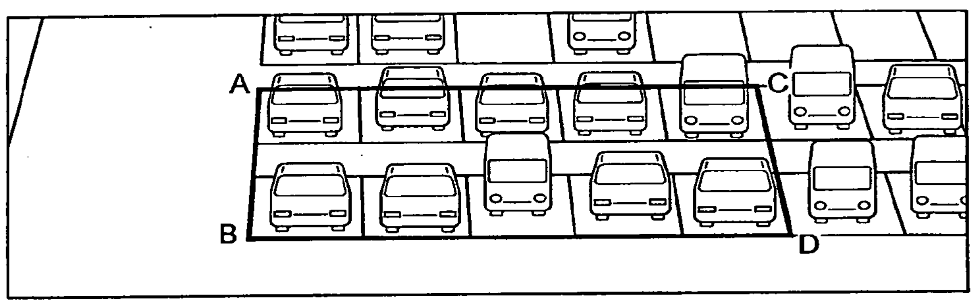


FIG. 11A

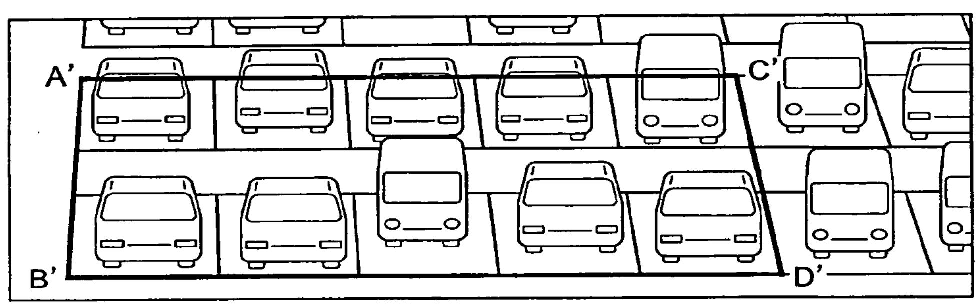


FIG. 11B

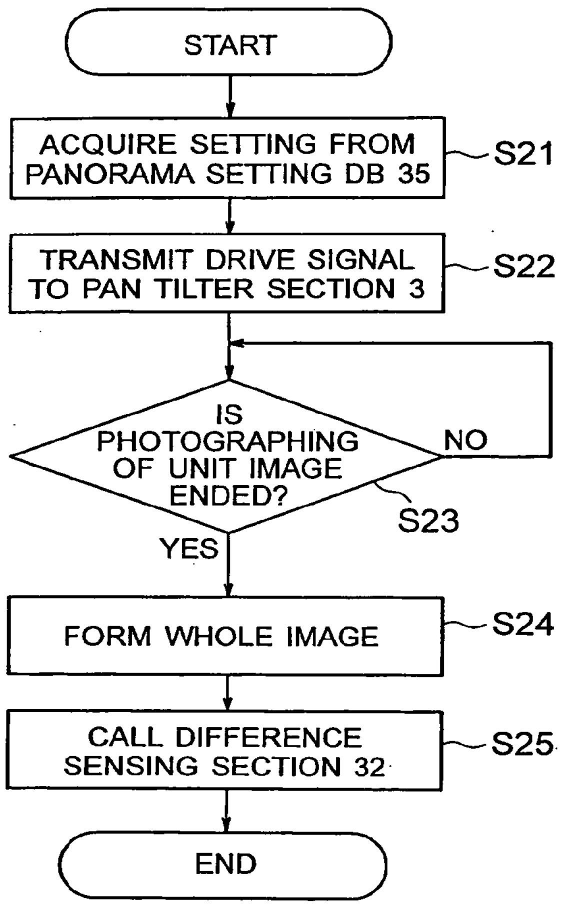

START
ACQUIRE SETTING FROM PANORAMA SETTING DB 35
S21
TRANSMIT DRIVE SIGNAL TO PAN TILTER SECTION 3
S22
IS PHOTOGRAPHING OF UNIT IMAGE ENDED?
NO
S23
YES
FORM WHOLE IMAGE
S24
CALL DIFFERENCE SENSING SECTION 32
S25
END

FIG. 12

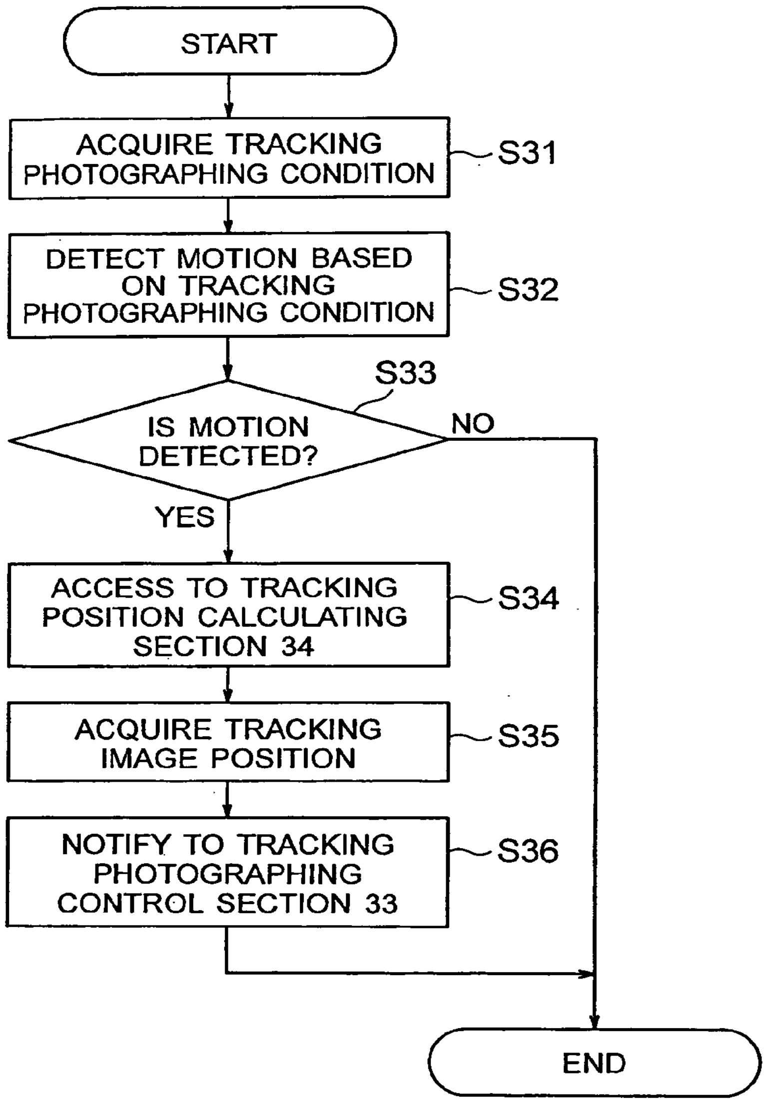

START
ACQUIRE TRACKING PHOTOGRAPHING CONDITION
S31
DETECT MOTION BASED ON TRACKING PHOTOGRAPHING CONDITION
S32
S33
IS MOTION DETECTED?
NO
YES
ACCESS TO TRACKING POSITION CALCULATING SECTION 34
S34
ACQUIRE TRACKING IMAGE POSITION
S35
NOTIFY TO TRACKING PHOTOGRAPHING CONTROL SECTION 33
S36
END

FIG. 13

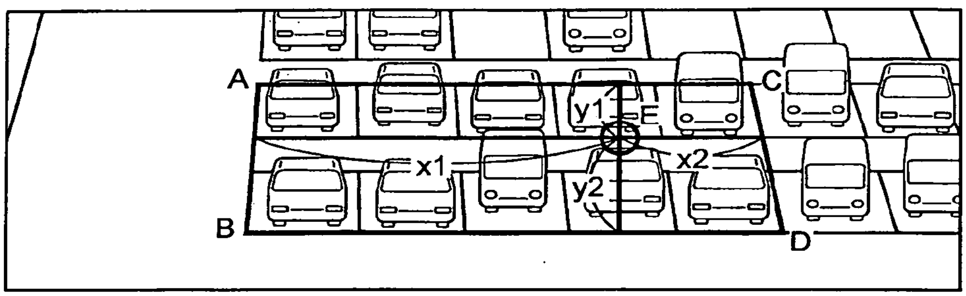


FIG. 14A

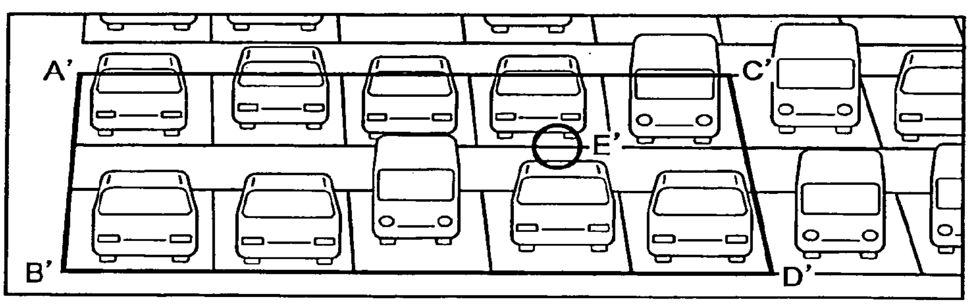


FIG. 14B

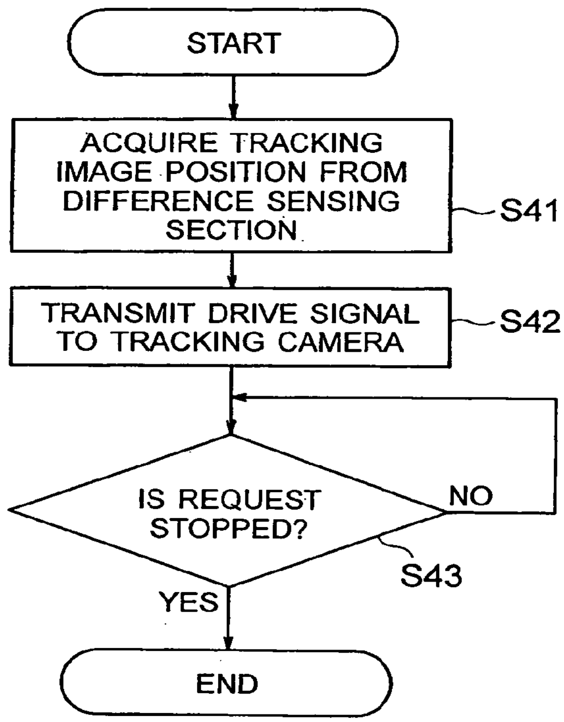
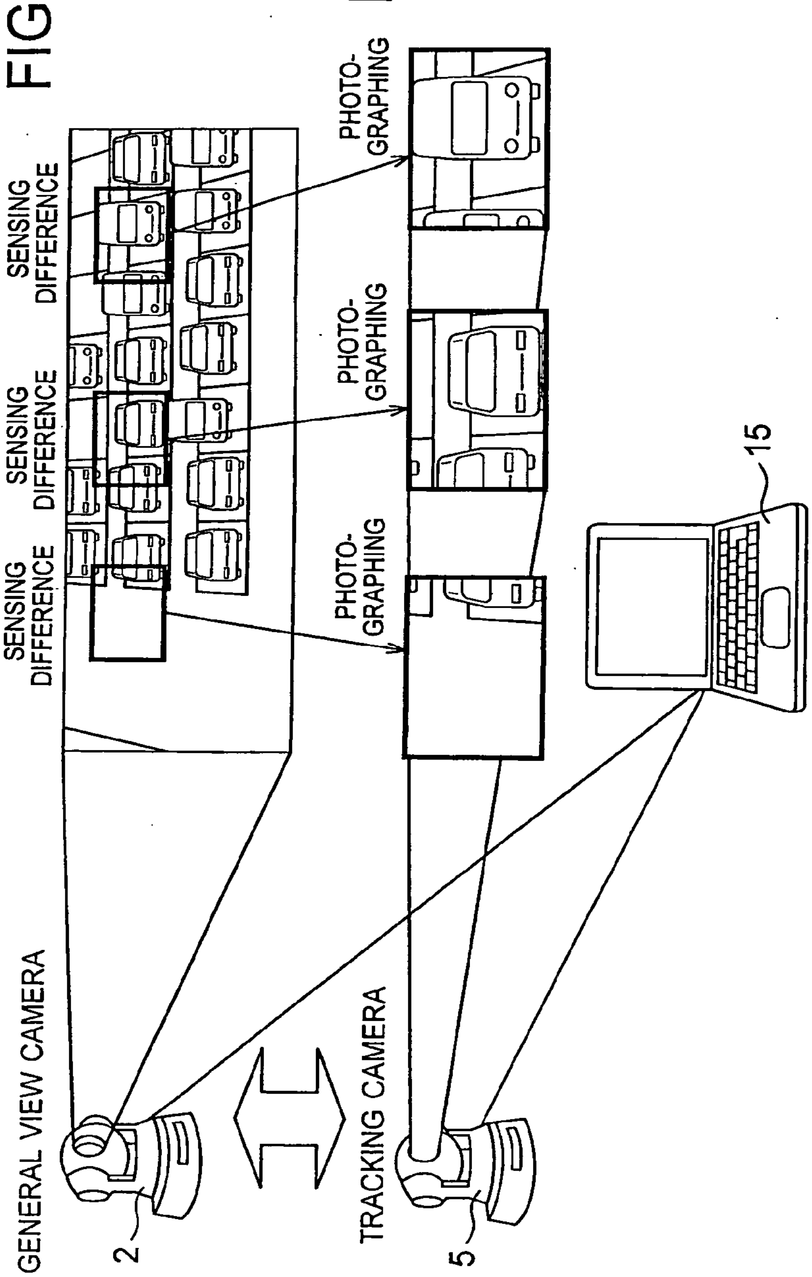

START
ACQUIRE TRACKING IMAGE POSITION FROM DIFFERENCE SENSING SECTION
S41
TRANSMIT DRIVE SIGNAL TO TRACKING CAMERA
S42
IS REQUEST STOPPED?
NO
S43
YES
END

FIG. 15

FIG. 16A

FIG. 16B



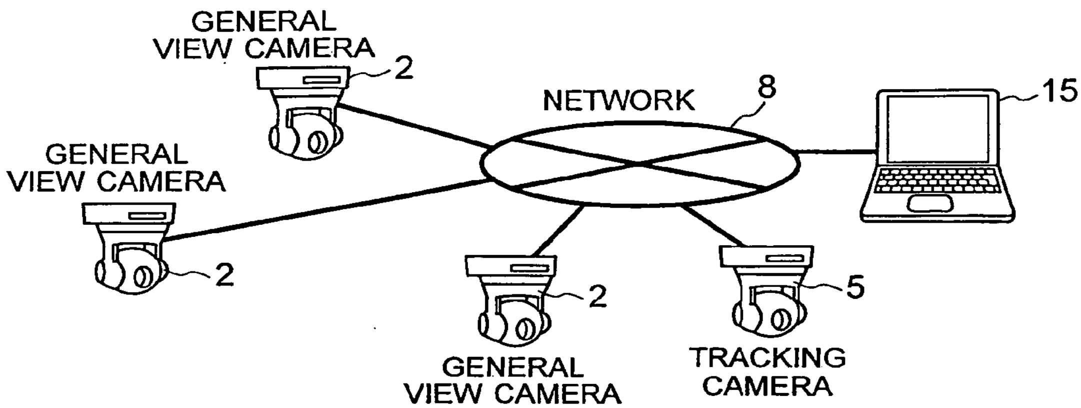

GENERAL
VIEW CAMERA
2
NETWORK
8
15
GENERAL
VIEW CAMERA
2
2
5
GENERAL
VIEW CAMERA
TRACKING
CAMERA

FIG. 17

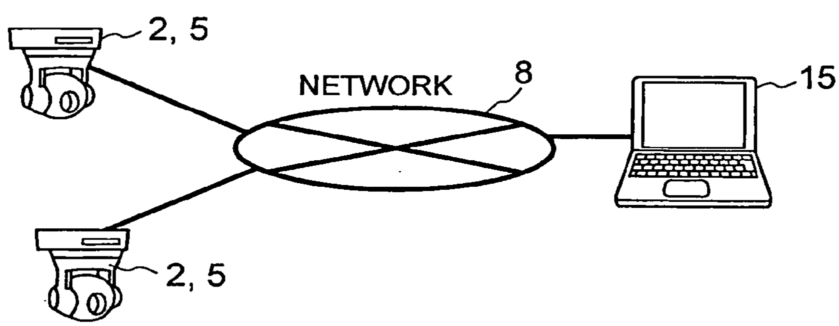

2, 5
NETWORK
8
15
2, 5

FIG. 18

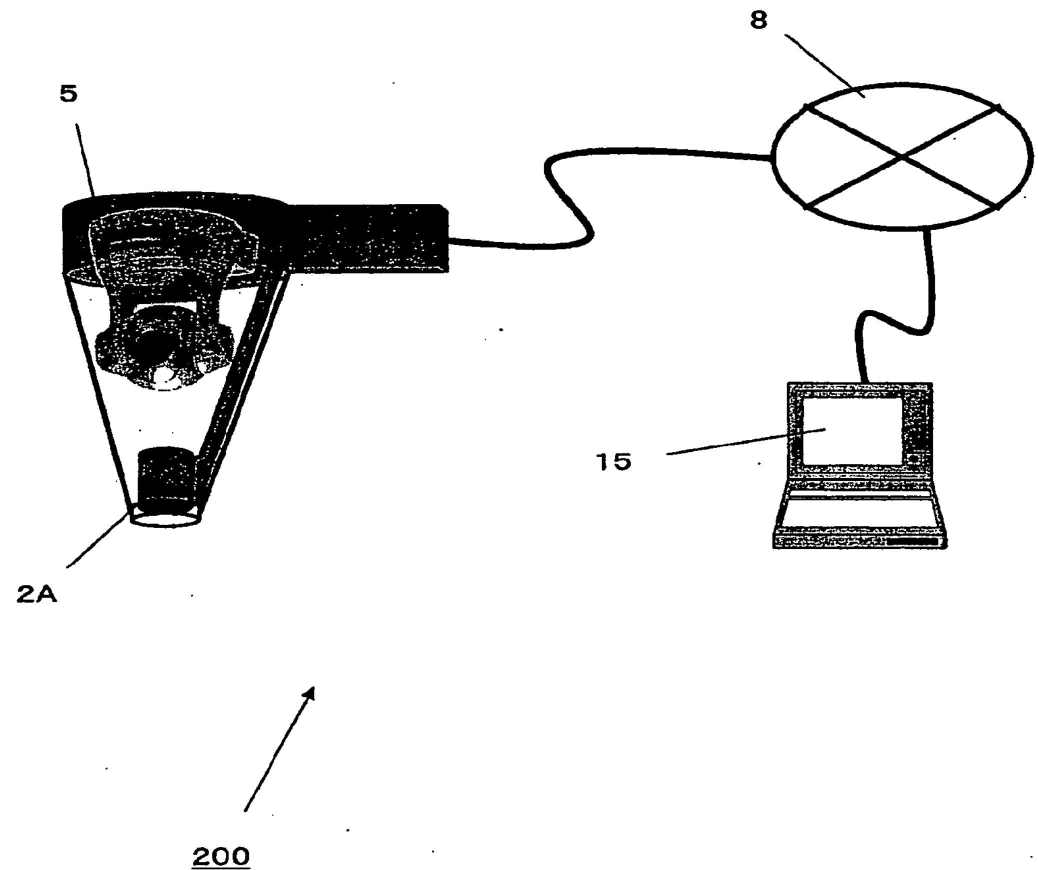


FIG.19

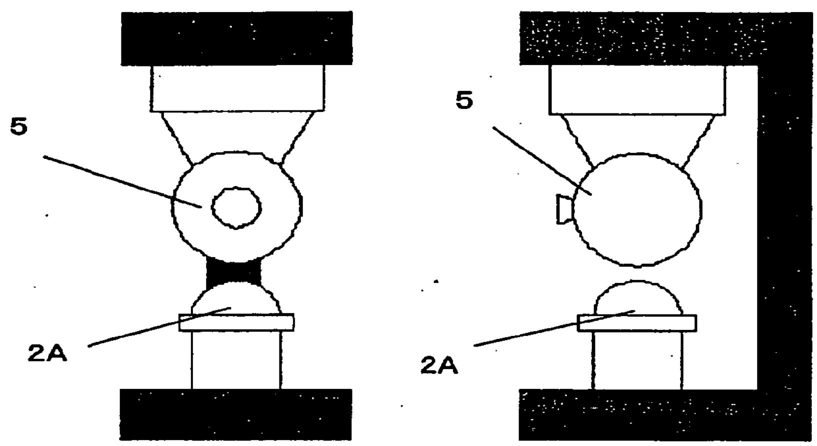


FIG.20A FIG.20B

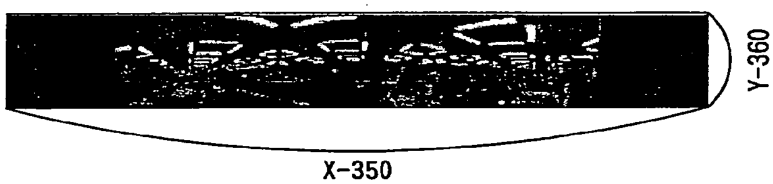


FIG.21

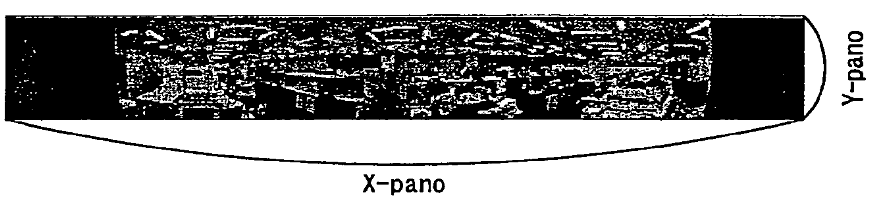


FIG.22

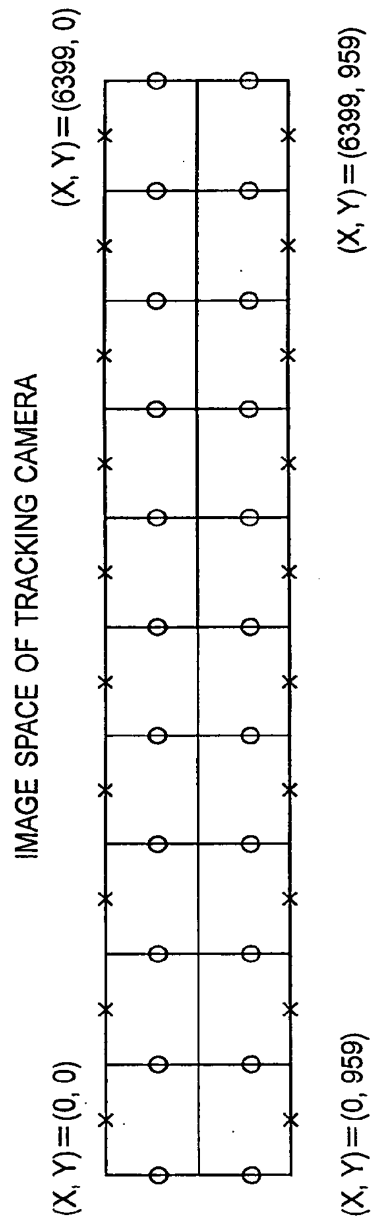


IMAGE SPACE OF TRACKING CAMERA
(X, Y)=(6399, 0)
(X, Y)=(6399, 959)
(X, Y)=(0, 0)
(X, Y)=(0, 959)

FIG. 23

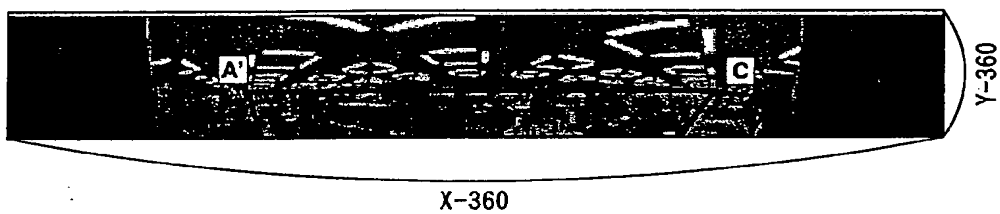


FIG.24

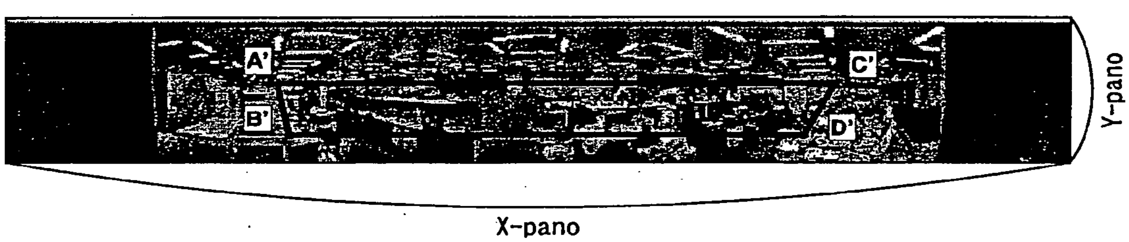


FIG.25

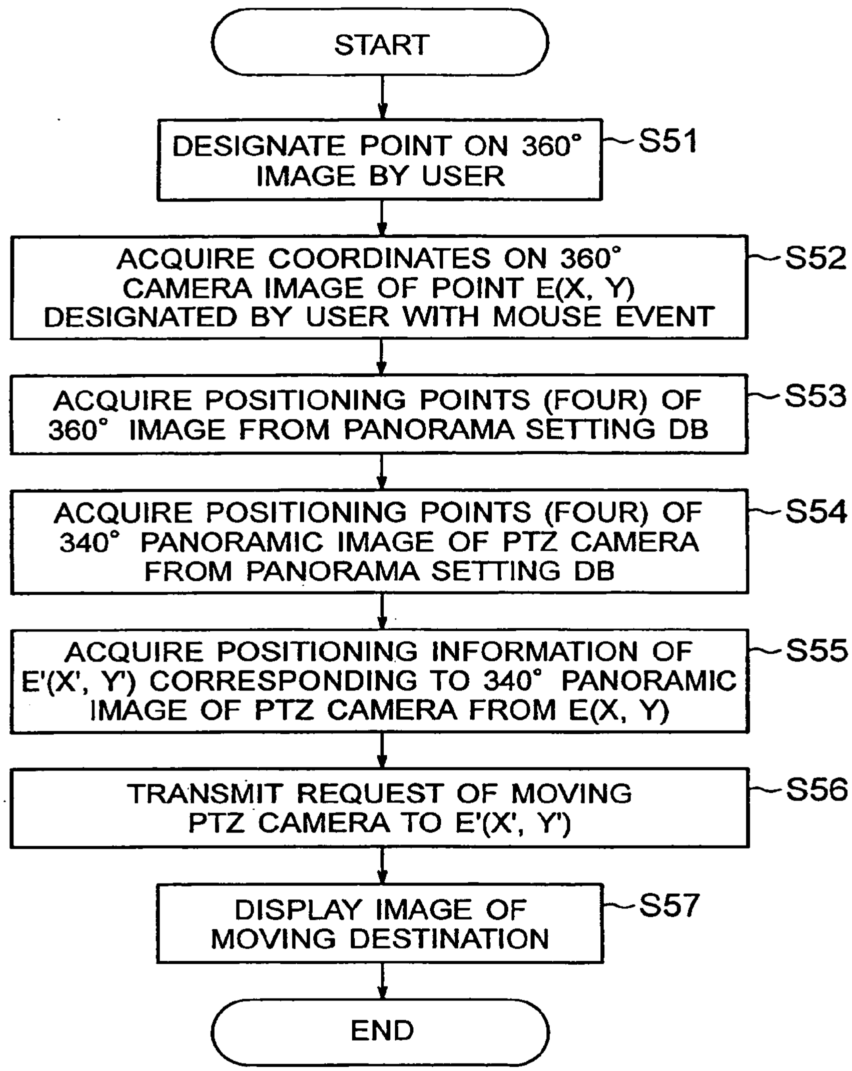

START
DESIGNATE POINT ON 360° IMAGE BY USER
S51
ACQUIRE COORDINATES ON 360° CAMERA IMAGE OF POINT E(X, Y) DESIGNATED BY USER WITH MOUSE EVENT
S52
ACQUIRE POSITIONING POINTS (FOUR) OF 360° IMAGE FROM PANORAMA SETTING DB
S53
ACQUIRE POSITIONING POINTS (FOUR) OF 340° PANORAMIC IMAGE OF PTZ CAMERA FROM PANORAMA SETTING DB
S54
ACQUIRE POSITIONING INFORMATION OF E'(X', Y') CORRESPONDING TO 340° PANORAMIC IMAGE OF PTZ CAMERA FROM E(X, Y)
S55
TRANSMIT REQUEST OF MOVING PTZ CAMERA TO E'(X', Y')
S56
DISPLAY IMAGE OF MOVING DESTINATION
S57
END

FIG. 26

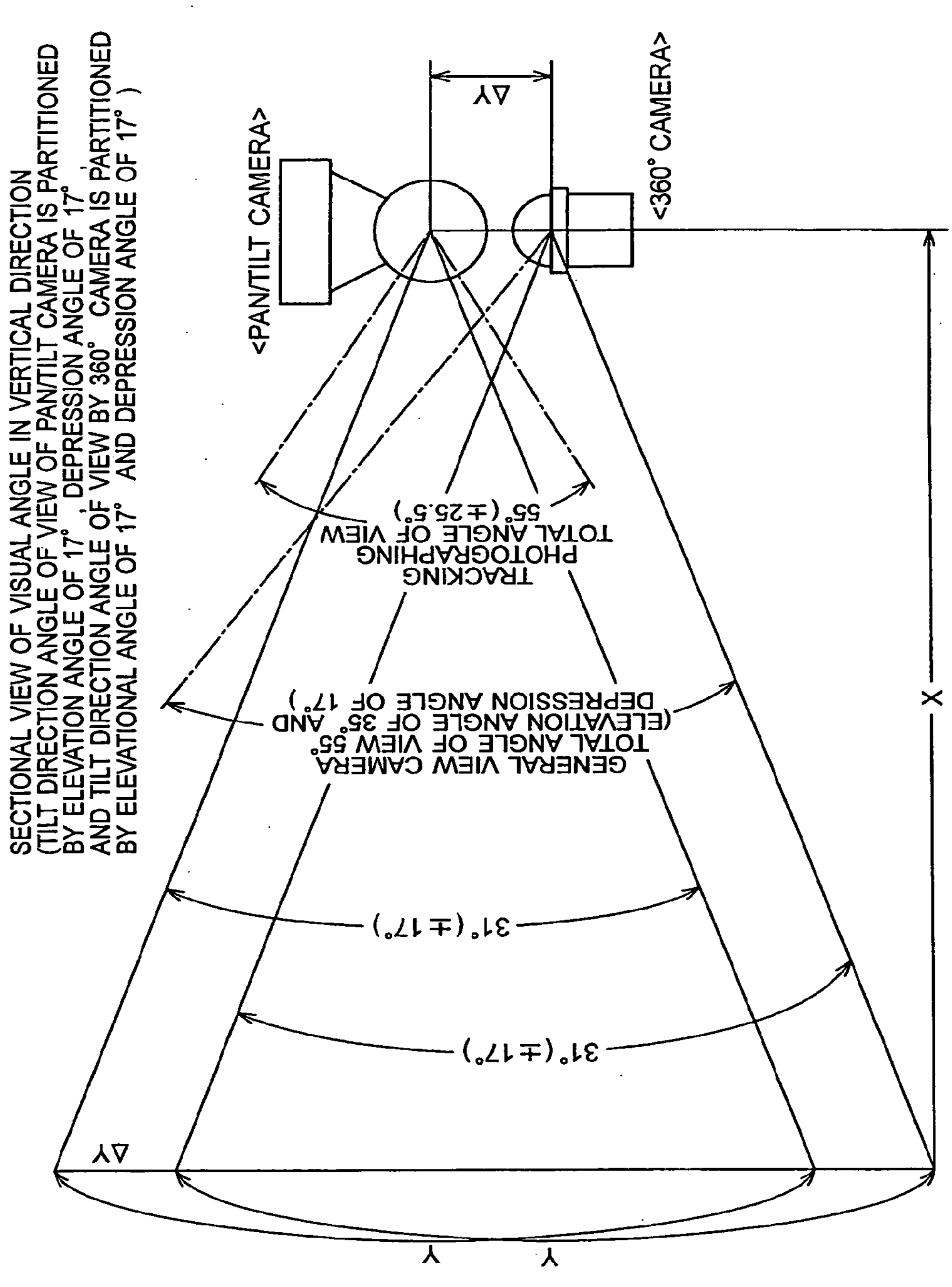

SECTIONAL VIEW OF VISUAL ANGLE IN VERTICAL DIRECTION
(TILT DIRECTION ANGLE OF VIEW OF PAN/TILT CAMERA IS PARTITIONED BY ELEVATION ANGLE OF 17°, DEPRESSION ANGLE OF 17°
AND TILT DIRECTION ANGLE OF VIEW BY 360° CAMERA IS PARTITIONED BY ELEVATIONAL ANGLE OF 17° AND DEPRESSION ANGLE OF 17°)
<PAN/TILT CAMERA>
<360° CAMERA>
ΔY
TRACKING PHOTOGRAPHING TOTAL ANGLE OF VIEW 55° (±25.5°)
GENERAL VIEW CAMERA TOTAL ANGLE OF VIEW 55° (ELEVATION ANGLE OF 35° AND DEPRESSION ANGLE OF 17°)
31° (±17°)
31° (±17°)
ΔY
Y
Y
X

FIG. 27

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 02 8026

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X Y	US 2002/075258 A1 (PARK MICHAEL C ET AL) 20 June 2002 (2002-06-20) * paragraph [0018] * * paragraph [0026] - paragraph [0033] * * paragraph [0037] - paragraph [0039] * * paragraph [0045] - paragraph [0050] * * paragraph [0058] - paragraph [0064] * * paragraph [0118] * * paragraph [0125] - paragraph [0126] * * paragraph [0137] - paragraph [0138] * * figures 1,3a,3b,4a * -----	1,2,4-6, 10,13 3,7-9, 11,12	H04N5/232 H04N5/262
Y	EP 1 363 255 A (SONY CORPORATION) 19 November 2003 (2003-11-19) * column 4, paragraph 22 * * column 7, paragraph 34 * * column 7, paragraph 39 - column 8, paragraph 40 * -----	3,7-9, 11,12	
X	EP 0 714 081 A (SENSORMATIC ELECTRONICS CORPORATION) 29 May 1996 (1996-05-29) * column 2, line 19 - column 4, line 52 * * figures 1-3 * -----	1-3,5,6, 10,13	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04N
D,A	EP 1 030 519 A (SONY CORPORATION) 23 August 2000 (2000-08-23) * the whole document * -----	1	
D,A	PATENT ABSTRACTS OF JAPAN vol. 1998, no. 09, 31 July 1998 (1998-07-31) & JP 10 108163 A (SONY CORP), 24 April 1998 (1998-04-24) * abstract * -----	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 March 2005	Didierlaurent, P

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

4

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 02 8026

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

08-03-2005

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		US 6323858 B1	27-11-2001
		WO 03036567 A1	01-05-2003
		US 2002180759 A1	05-12-2002
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EP 1030519 A	23-08-2000	JP 2000243062 A	08-09-2000
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JP 10108163 A	24-04-1998	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan

PUBLICATION NUMBER : 2008076485
PUBLICATION DATE : 03-04-08

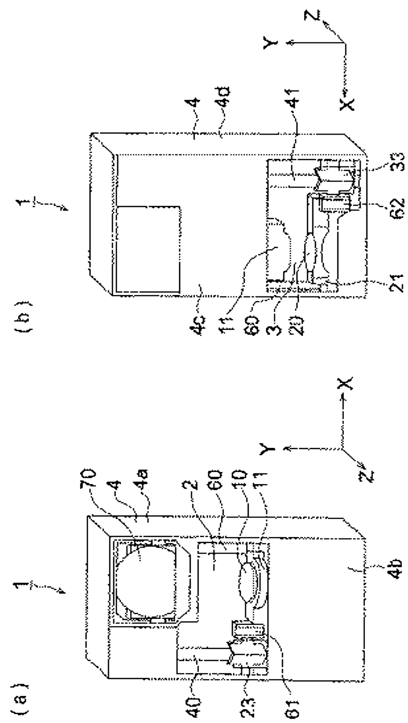
APPLICATION DATE : 19-09-06
APPLICATION NUMBER : 2006252495

APPLICANT : KONICA MINOLTA OPTO INC;

INVENTOR : MITANI YOSHIJI;

INT.CL. : G02B 7/04 (2006.01), G02B 7/08 (2006.01)

TITLE : LENS BARREL AND IMAGING APPARATUS

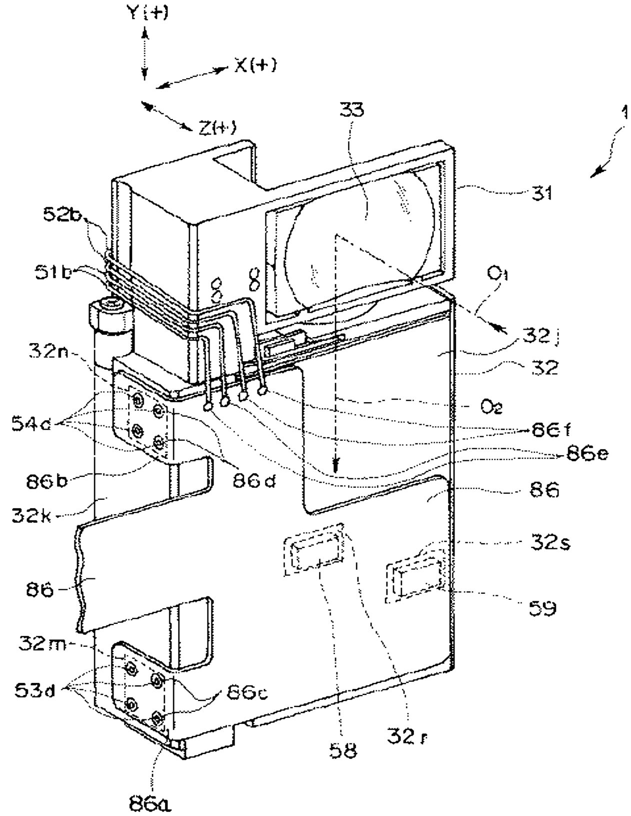


ABSTRACT : PROBLEM TO BE SOLVED: To provide a lens barrel that is small and rigid and can easily be incorporated and to provide a small imaging apparatus.

SOLUTION: The box-shaped lens barrel includes: an imaging optical system having two lens groups held in lens frames; and two drive shafts for supporting the respective lens frames so that they are movable relative to each other in the direction of an optical axis. In the lens barrel, openings are made in opposite walls of the lens barrel, which are orthogonal to a plane including the two drive shafts so as to be displaced from each other in the direction of the optical axis.

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan



PUBLICATION NUMBER : 2004133054
PUBLICATION DATE : 30-04-04

APPLICATION DATE : 08-10-02
APPLICATION NUMBER : 2002295258

APPLICANT : OLYMPUS CORP;

INVENTOR : FUTAMI AKIRA;

INT.CL. : G02B 7/02 G02B 7/04 G02B 7/08 G03B 9/14 G03B 9/26 H04N 5/225

TITLE : LENS BARREL

ABSTRACT : PROBLEM TO BE SOLVED: To provide a lens barrel made reliable, and made small in size and thin in thickness.

SOLUTION: The lens barrel 10 has a 1st group frame 31 and a fixed frame 32, and incorporates a prism to refract subject luminous flux from an incident optical axis to an optical axis being in a perpendicular direction in the 1st group frame. A lens group capable of moving forward and backward, a shutter unit and a CCD or the like are arranged in the frame 32, and a solenoid for driving a shutter is arranged on the left side of the frame 31 and a step motor for driving a lens group is arranged on the left side wall part 32k of the frame 32. PRs 58 and 59 for detecting the position of a lens group are positioned on a front side wall part 32j and mounted on an FPC for connection 86, and the motor terminals 53d and 54d of the step motor are inserted through the insertion holes 32m and 32n of the wall part 32k to the outside and connected to the FPC 86. By arranging the solenoid and the step motor on the left side of the frame member, the lens barrel is thinned.

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United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

7590 12/10/2018

Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

EXAMINER	
TRAN, NHAN T	
ART UNIT	**PAPER NUMBER**
2664	
NOTIFICATION DATE	**DELIVERY MODE**
12/10/2018	ELECTRONIC

NOTICE OF NON-COMPLIANT INFORMATION DISCLOSURE STATEMENT

An Information Disclosure Statement (IDS) filed 11·25·18 in the above-identified application fails to meet the requirements of 37 CFR 1.97(d) for the reason(s) specified below. Accordingly, the IDS will be placed in the file, but the information referred to therein has not been considered.

The IDS is not compliant with 37 CFR 1.97(d) because:

☒ The IDS lacks a statement as specified in 37 CFR 1.97(e).

☐ The IDS lacks the fee set forth in 37 CFR 1.17(p).

☐ The IDS was filed after the issue fee was paid. Applicant may wish to consider filing a petition to withdraw the application from issue under 37 CFR 1.313(c) to have the IDS considered. See MPEP 1308.

N. Hoare

571-272-4200 or 1-888-786-0101
Application Assistance Unit
Office of Data Management

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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

92342 7590 12/13/2018
Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101
ISRAEL

EXAMINER	
TRAN, NHAN T	

ART UNIT	PAPER NUMBER
2664	

NOTIFICATION DATE	DELIVERY MODE
12/13/2018	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

amirr@natpatent.com
dorong@natpatent.com
info@natpatent.com

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U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR/ PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
15/324,720	01/08/2017	Cohen et al.	COREPH-0159 US NP

Nathan & Associates Patent Agents Ltd
P.O.Box 10178
Tel Aviv, 6110101

EXAMINER	
NHAN T TRAN	
ART UNIT	PAPER
2664	20181208

DATE MAILED:

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

The IDS filed on 9/23/2018 contains invalid reference number 98896655 at item 89. This reference could not be identified and has been crossed out from consideration by the Examiner.

See attached document.

/NHAN T TRAN/
Primary Examiner, Art Unit 2664

PTO-90C (Rev.04-03)

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code1	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9286680	B1	2016-03-15	Jiang et al.	
	2	9736391	B2	2017-08-15	Du et al.	
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	8	5444478	A	1995-08-22	Lelong et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	9	5657402	A	1997-08-12	Bender et al.	
	10	5682198	A	1997-10-28	Katayama et al.	
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	15	7002583	B2	2006-02-21	Maurice F. Rabb, III	
	16	7346217	B1	2008-03-18	V. Edward Gold, Jr.	
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.P./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	20	6268611	B1	2001-07-31	Pettersson et al.	
	21	6714665	B1	2004-03-30	Hanna et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	31	5768443	A	1998-06-16	Michael et al.	
	32	6101334	A	2000-08-08	Stephen D. Fantone	
	33	6611289	B1	2003-08-26	Yu et al.	
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	42	5436660	A	1995-07-25	Yukio Sakamoto	
	43	6549215	B2	2003-04-15	Norman P. Jouppi	
	44	7411610	B2	2008-08-12	Michael Doyle	
	45	8439265	B2	2013-05-14	Ferren et al.	
	46	5248971	A	1993-09-28	William J. Mandl	
	47	5459520	A	1995-10-17	Tadao Sasaki	
	48	7038716	B2	2006-05-02	Klein et al.	
	49	7339621	B2	2008-03-04	Justin Fortier	
	50	9215385	B2	2015-12-15	Xiaodong Luo	
	51	7305180	B2	2007-12-04	Labaziewicz et al.	
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.P./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	53	7199348	B2	2007-04-03	Olsen et al.	
	54	8115825	B2	2012-02-14	Culbert et al.	
	55	7964835	B2	2011-06-21	Olsen et al.	
	56	8154610	B2	2012-04-10	Jo et al.	
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	59	5982951	A	1999-11-09	Katayama et al.	
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	61	9025073	B2	2015-05-05	Attar et al.	
	62	9025077	B2	2015-05-05	Attar et al.	
	63	9413984	B2	2016-08-09	Attar et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.P./

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	64	9578257	B2	2017-02-21	Attar et al.	
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(Typed or printed name)

(Signature)

(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	01/08/2017	Noy Cohen	COREPH-0159 US NP	5811

TITLE OF INVENTION: DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$500	$0.00	$0.00	$500	02/19/2019

EXAMINER	ART UNIT	CLASS-SUBCLASS
TRAN, NHAN T	2664	348-240990

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Nathan & Associates
2 Menachem Nathan
3 ______

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Corephotonics Ltd.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Tel Aviv, Israel

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies ______

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

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☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. ______

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
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NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature / Menachem Nathan / Date 2019/01/03

Typed or printed name MENACHEM NATHAN Registration No. 65392

Electronic Patent Application Fee Transmittal

Application Number:	15324720
Filing Date:	08-Jan-2017
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Filer:	Menachem Nathan
Attorney Docket Number:	COREPH-0159 US NP

Filed as Small Entity

Filing Fees for U.S. National Stage under 35 USC 371

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**500**

Electronic Acknowledgement Receipt

EFS ID:	34771079
Application Number:	15324720
International Application Number:	
Confirmation Number:	5811
Title of Invention:	DUAL APERTURE ZOOM CAMERA WITH VIDEO SUPPORT AND SWITCHING / NON-SWITCHING DYNAMIC CONTROL
First Named Inventor/Applicant Name:	Noy Cohen
Customer Number:	92342
Filer:	Menachem Nathan
Filer Authorized By:	
Attorney Docket Number:	COREPH-0159 US NP
Receipt Date:	05-JAN-2019
Filing Date:	08-JAN-2017
Time Stamp:	04:06:46
Application Type:	U.S. National Stage under 35 USC 371

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$500
RAM confirmation Number	010719INTEFSW04080600
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The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_fee.pdf	271252 cab5f3acb94f3fc88fc31c6246e8fdb7d5645586	no	1
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30199 9675d0f004c90404e4707d3b84281639l2f6a86d	no	2
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		Total Files Size (in bytes):	301451		

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If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE DESCRIPTION:

Change(s) applied to document, /J.M.C./ 12/6/2018

Please amend the paragraph on page 12, line 31 ~~lines 24-28~~ as follows:

Returning now to the Zoom-in process, in some embodiments, for higher ZF than the up-transfer ZF, the output is the transformed Tele camera output, digitally zoomed. However, in other embodiments, for higher ZF than the up-transfer ZF, there will be no switching from the Wide to the Tele camera output, i.e. the output will be from the Wide camera, digitally zoomed. This "no switching" process is described next.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

	73	20040061788	A1	2004-04-01	John Bateman	
	74	20150215516	A1	2015-07-30	Benjamin P. Dolgin	
	75	20140313316	A1	2014-10-23	Olsson et al.	
	76	20110229054	A1	2011-09-22	Weston et al.	
	77	20020063711	A1	05/2002 ~~2016-06-14~~	Park et al.	
Change(s) applied to document, /R.S./ 12/7/2018	78	20090128644	A1	2009-05-21	Camp et al.	
	79	20130321668	A1	2013-12-05	Ajith Kamath	
	80	20130202273	A1	2013-08-08	Ouedraogo et al.	
	81	20120069235	A1	2012-03-22	Francisco Imai	
	82	20130002928	A1	2013-01-03	Francisco Imai	
	83	20120105579	A1	2012-05-03	Jeon et al.	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /N.P./

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	15324720
	Filing Date	2017-01-08
	First Named Inventor	Noy Cohen
	Art Unit	
	Examiner Name	
	Attorney Docket Number	COREPH-0159 US NP

U.S.PATENTS

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	9286680	B1	2016-03-15	Jiang et al.	
	2	9736391	B2	2017-08-15	Du et al.	
	3	9894287	B2	2018-02-13	Qian et al.	
	4	6750903	B1	2004-06-15	Miyatake et al.	
	5	5032917	A	1991-07-16	Felix Aschwanden	
	6	5287093	A	1994-02-15	Amano et al.	
	7	5287093	A	02/1994 ~~1995-02-28~~	Amano et al. ~~John T. Hall~~	
Change(s) applied to document, /R.S./ 12/7/2018	8	5444478	A	1995-08-22	Lelong et al.	

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
15/324,720	03/12/2019	10230898	COREPH-0159 US NP	5811

92342 7590 02/20/2019

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ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

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